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THE GENUS OECLEUS IN THE UNITED STATES
(Homoptera: Fulgoridae)

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The genus *Oecleus* belongs to that division of the family *Cixidae* in which the end of the female abdomen is modified into a large transverse wax-forming plate to the lower margin of which the reduced pygofers and ovipositor are attached. The following key will enable one to readily determine the common genera.

Key to the More Common Genera of the Cixidae (With Wax Plates)

A. Vertex broad, nearly flat, face broad, cubitus (inner nervure of corium) forking near middle of clavus.
  B. Mesonotum tricarinate.....*Cixius* Latr.
  BB. Mesonotum 5-carinate.....*Oliarus* Stål.
AA. Vertex a narrow trough between high carinae, face narrow; cubitus forking at or very near apex of clavus.
  B. Vertex very narrow at the base, broadening apically, 5-carinae on mesonotum.....*Oecleus* Stål.
  BB. Vertex broadest at the base, narrowing apically, 3 carinae on mesonotum.....*Oeclidius* Van D.

The three plates are arranged, numbered and named in the same order as the key and text, and are therefore self explanatory.

DISTRIBUTION

This genus is decidedly western in its development on this continent. Only one species is abundant along the Atlantic seaboard and another is here described from southern Florida. The remainder of the twenty-four enumerated are typically western, a few being found as far east as the plains region, but only two of these extending into the Mississippi Valley proper. None of the species has been taken as far north as Canada, but a number are distributed along the southern border and extend over into Mexico.

KEY TO THE SPECIES

A. Head in profile acutely angled, or at least nearly right angled.
B. Costal nervure of elytra broadened around the basal angle to more than three times its width at the nodal cell and often pustulate. Elytra usually broad and short, (except in **subreflexus**).
C. Large broad-winged species females 3.5 by 8 mm. or longer.
D. Light tawny, or yellow. Vertex about right angled, nodal cell equal in length and breadth.....(S. W.) **1. snowi**
DD. Darker. Vertex acutely angled, nodal cell longer than wide.
E. Third anteapical shorter or only equal the fourth with two apical nervures, each with a single fork. Elytra with a slight tawny tinge.....(Ariz.) **2. capitulatus**
EE. Third anteapical longer than the fourth, giving off three apical veins or two veins that fork again. Elytra pale milky, (Ariz.) **3. triplicatus**
CC. Smaller species, females not over 6 mm.
F. Elytra broad and short, not more than one-half longer than wide. Elytra milky, not yellow.
G. Third anteapical cell shorter or only equalling the fourth. Nodal cell much longer than wide, the inner margin only broadly arched, (Ariz.) **4. arnellus**
GG. Third anteapical cell much exceeding the fourth, nodal cell short and broad, the inner margin sharply arched, (Ariz. and Calif.) **5. centronus**
FF. Elytra longer and narrower, nearly twice longer than wide. Species small, entirely pale yellow or with dark lines on mesonotum.
H. Elytra pale, unmarked, or with trace of dots towards apex, vertex narrow.....(S. W.) **6. subreflexus**
HH. Elytra with black dots on veins and a black stigma. Vertex broadening in front.....(Nev.) **7. sagittanus**
BB. Costal nervure but little broadened at the base and following the angle of the elytra.
I. Elytra with ground color tawny or pale tawny, size small.
J. Mesonotum yellow with a pair of heavy black stripes outside the carinae.....(S. W.) **8. planus**
JJ. Mesonotum pale brown with carinae light.
K. Elytra broad, golden yellow unmarked.....(Ariz.) **9. pulchellatus**
KK. Elytra long and slender, nervures and markings smoky, (S. Calif.) **10. cabazonus**
II. Elytra with the ground color subhyaline or milky (occasionally smoky).
L. Large straw-colored species, females 6–8 mm., with long, narrow acute vertices, and long narrow elytra.
M. Mesonotum with five light stripes on the carinae, nodal cell but little longer than broad, strongly arched.....(S. W.) **11. lineatus**
MM. Mesonotum with a broad median white stripe and a pair of narrow yellow ones on the lateral carinae, nodal cell twice longer than wide, scarcely arched.....(S. W.) **12. nolinus**
LL. Species smaller or darker or both.
N. Head in profile acutely angled, vertex extending beyond the eyes more than its width at apex.
O. Elytra smoky with heavy smoky or black markings. Large, with an extremely long vertex.....(Ariz.) **13. perpictus**
OO. Elytra hyaline with only the usual dots on nervures.
P. Vertex narrow at base, nodal cell longer than wide, elytra subhyaline, the nervures pale brown with faint dots, (Fla.) **14. tamiamus**
PP. Vertex very wide at base, nodal cell twice as long as wide, elytra milky with the nervures alternate black and white, (West) **15. excavatus**
NN. Head in profile a right angle or slightly acute, vertex not exceeding the eyes by more than its apical width.
Q. Mesonotum with 3 or 5 narrow light lines on the carinae.

R. Elytra subhyaline, the claval areas and cross nervures smoky, nervures alternate dark and white, in dark specimens the mesonotum is black with three very narrow lines, (West) **16. venosus**

RR. Elytra subhyaline with a tawny cast, the nervures pale brown, becoming darker towards apex, dots obscure...(East) **17. borealis**

QQ. Mesonotum black with two broad yellow lines between the carinae and two short ones outside.....(Ariz.) **18. quadrilineatus**

AA. Head in profile decidedly rounding, definitely less than a right angle with the vertex extending beyond the eye, less than its width.

B. Face black, general body color dark. The mesonotum may be orange. the elytra subhyaline, females 6 mm. or over.

C. Vertex very broad and short, not more than twice as long as its median width.....(S. W.) **19. campestris**

CC. Vertex narrower, especially at base, three or more times as long as its median width.....(Central and West) **20. decens**

BB. General body color pale or yellow, face usually yellow, species mostly small.

D. Species broad and stout, females more than 4 mm. long.

E. Elytra white, nervures concolorous with dark dots towards the apex.....(West) **21. fulvidorsum**

EE. Elytra tawny, nervures dotted throughout. Smoky dashes on the cross nervure and margins.....(Ariz.) **22. monilipennis**

DD. Species small, females 4 mm. or less.

F. Nervures of elytra dotted throughout, face pale or orange, (Ariz.) **23. piperatus**

FF. Nervures of elytra dark brown, the punctures obscured, face smoky.....(Ariz.) **24. pigmy**

FOOD PLANTS

The nymphs of this genus of *Fulgoridae* are covered with a white wax and are either subterranean or hide in the protected parts of their food plants so that they are rarely seen, thus making accurate food plant determination difficult. The adults of the two common species, *borealis* of the Atlantic coast and *decens* of the Southwest and Mexico, are found on a wide variety of trees and shrubs and are either general feeders or else their larval food plants are low growing but widely distributed plants from which the adults fly up to the higher vegetation. Five species are known to feed on different salt bushes (*Atriplex*), one on *Salicornia* and one on *Dondia*—making seven feeding on *Chenopodiaceae;* five feed on different *Compositae*, two on relatives of the yuccas, one on currant, one on the desert Catalpa, and one on a grass, leaving seven species with food plants unknown.

Genus **Oecleus** Stål

Oecleus Stål. Berl. Ent. Zeit. 6: 306, 1862.

Species of moderate size with membraneous elytra longer than abdomen, tectiform when closed but not overlapping and without granulations on clavus. Head very narrow, less than half as wide as

the pronotum. The vertex narrow especially at the base where it is truncate, appearing as a deep trough between the elevated lateral carinae. Front long and narrow. Pronotum roundingly emarginate posteriorly, much shorter on median line than vertex. Mesonotum broad, 5-carinate. Elytra broad, nearly parallel margined, the cubitus running close to and parallel with the claval suture and only forking near the apex of clavus. Subcosta (+ R) and medius united for at least one-third the distance to the stigma. Apex of female abdomen terminating in a broad transverse wax plate from the ventral margin of which the reduced ovipositor extends.

Type of genus *Oecleus seminiger* Stål (from Mexico).

CHARACTERS USED IN CLASSIFICATION

The most important characters are found in the relative width and length of the vertex, whether it is parallel margined or expands apically, the relative projection beyond the eyes and the angle formed with the front, the width of the costal nervure around the basal angle, the size and shape of the stigma and the nodal cell, the relative length of the anteapical cells, the size and color of the setigerous punctures on the nervures, the shape of the projection on the apex of the male genital segment and the color especially of the face and elytra. The shape of the male genital styles which is one of the best of diagnostic characters in some of the allied genera is of little value here. They are all of one general pattern, club-shaped, covered with spines and with a definite chitinized hook apically. They are hinged so that they may move in and out and thus change their apparent length and they are usually covered with wax and thus obscured.

The types of the new species described are in the collection of the senior author, unless otherwise stated.

1. **Oecleus snowi** Ball

(Plate I, Fig. 1; Plate II, Fig. 1)

Oecleus snowi Ball. Proc. Biol. Soc. Wash. 18: 117, 1905.
Oecleus decens Fowl. Biol. Centr. Amer. Homop. 1: 90, Pl. 10, Fig. 6, 1904. (Not Stål.)

Large broad-winged, pale lemon-yellow nearly twice as broad as *decens*, vertex right-angled, costal nervure broadly expanded basally. Length ♀ 8 mm, ♂ 6.5 mm., width 3 mm.

Vertex very narrow nearly parallel margined, converging posteriorly vertex and front in profile forming a right angle, the vertex projecting beyond the eye more than its width at apex. Front narrow with prominent lateral carinae, almost four times as wide between antennae as at apex, obtusely angulate above, in profile slightly convex. Elytra

very broad, two and one-half times as long as broad. Costal vein widening towards the basal angle where it leaves the margin forming a broad band four times its width at node. There are setigerous punctures on this vein but not between it and margin. Nodal cell almost as broad as long, inner margin strongly arched. Twelve apical cells. The second and third anteapicals extending beyond the first at least their width. Male genital segment deeply emarginate with a broad rectangular median projection, the posterior margin with two spines and a fingerlike median process.

Color bright straw yellow with brownish or smoky cast. Mesonotum and face tawny. Elytra subhyaline yellow, often with a smoky cast. Nervures concolorous with sparse black setigerous punctures. Usually the darkening on the mesonotum intensified against outer carinae.

Habitat: Specimens are at hand from Bill Williams Fork (Snow), Wickenburg, Phoenix, Safford (Ball), Tucson, Chiricahua Mts. (Nichols), and Nogales, Arizona, and Ontario, California (Ball). Van Duzee reports it from Potholes, California. Fowler lists and figures it as *decens* from Mexico. Feeds on the Water Wally (*Baccharis glutinosa*) growing in the dry washes of the western deserts. Hibernates as an adult and so occurs throughout the season. This large, broad-winged, yellow species is strikingly distinct and cannot be confused with any other.

2. **Oecleus capitulatus** Van D.

(Plate II, Fig. 2)

Oecleus capitulatus Van Duzee. Bul. Buf. Soc. Nat. Sci. 10: 495, 1912.

Resembles *snowi* in size and form, vertex longer. Smoky brown with subhyaline elytra. Length ♀ 7.5 mm., ♂ 6.5 mm., width 3.2 mm.

Vertex broadening anteriorly, projecting one-half farther beyond the eye than in *snowi*. Profile convex but lacking the obtuse angle, forming a slightly acute angle with face. Face slightly broader opposite antennae than in *snowi*. Elytra similar to *snowi*. The costa narrower at the basal angle with setigerous punctures along inner margin. Nodal cell longer than broad and inner margin less arched than in *snowi*. Apices of first three anteapical cells usually a straight line. Male genitalia similar to *snowi* except that the basal projection narrows apically.

Color smoky brown, face darker, all carinae light. Elytra subhyaline with a definite smoky cast, nervures concolorous on basal half and usually dark smoky on the apical portion with numerous black setigerous punctures throughout. A pair of black lines on the middle of the sutural margin, another pair at apex of clavus and usually the scutellar margins are infuscate. The stigma with the inner margin dark lined, inner margin of nodal cell often darkened.

Habitat: Found breeding in abundance in May and June on *Dasylirion* (saw tooth yucca) growing on the slopes of the Santa Rita and Huachuca Mts. in Arizona (Ball).

3. **Oecleus triplicatus** Ball & Klgb., n. sp.
(Plate I, Fig. 3; Plate II, Fig. 3)

Similar to *capitulatus* but darker and lacking the brown shade on elytra. Elytra narrower, costal nervure less thickened and much less angled at the base, two extra apical nervures. Length ♀ 7.5 mm.; width 3 mm.

Vertex slightly wider than in *capitulatus*. In profile similar to *snowi*, front wider above and less constricted between the eyes. Elytra very long, three times as long as broad. Costa narrower than in *capitulatus*, nodal cell nearly three times as long as broad and strongly arched, third anteapical cell extended beyond the adjacent ones nearly its apical width and giving rise to two extra veinlets. Male pygofers deeply excavated with a short quadrangular projection bearing two acute spines on the lateral angles and a median fingerlike process.

Color brown, face black, carinae testaceous, pronotum dark with light markings, mesonotum dark, carinae tawny. Elytra milky hyaline, nervures yellow, heavily punctured, and darkening apically. Stigma and inner curve of nodal cell darkened.

Holotype ♀ Huachuca Mts. June 15, 1930 and one paratype female Santa Rita May 30, 1930, taken by the senior author. Allotype and one paratype male Arizona. Cornell Univ., Lot 34 (Uhler collection) from the National Museum. Allotype and one paratype in National Museum.

4. **Oecleus arnellus** Ball & Klbg., n. sp.
(Plate II, Fig. 4)

Superficially resembling *decens* but very distinct in the broad, short elytra, heavy puctures, and the broad costa. Much broader and shorter with a broader vertex than any of the preceding species. Length ♂ 5 mm.; width ♂ 2.2 mm.

Vertex broad throughout, twice the width of *snowi*, front proportionately much broader. In profile front and vertex meeting in a right angle, the front rounding. Costal nervure not as broad as in *snowi*, but heavily setigerous around the angle, third anteapical cell broad and short about equalling the adjoining ones in length with a single nervure from each angle, both of which are forked. Veins heavily dotted with fuscous throughout; on the longitudinal nervures the dots are separated by less than twice their width. Male genital segment shallowly emarginate, with a very short, two spined produced portion and the usual fingerlike process.

Color—Black with the carinae light yellow, the pronotum straw color with four black dots, the elytra milky subhyaline with a touch of fulvous on the clavus and apical cells. Stigma rather large, black; the nervures thickly set with large, black punctures, the apical ones becoming fuscous before the margin, but not enlarged as in *centronus*.

Holotype ♂ and one paratype male Yarnell Heights, Arizona, July 21, 1929 (Ball). This is a very distinct species,

but may be very easily overlooked owing to its superficial resemblance to the *decens* group. Its broad, short elytra with the extremely heavy dots will at once distinguish it.

5. **Oecleus centronus** Ball & Klbg., n. sp.

(Plate I, Fig. 5; Plate II, Fig. 5)

Similar to *snowi* but smaller, broader. Elytra milky with two fulvous bands across the extremities of the anteapicals. Length ♀ 5 mm., width 2 mm.

Vertex narrower at base and wider at apex than in *snowi*. In profile face less angled above and face and vertex slightly more acutely angled. Costal nervure slightly less broadened, but elytra slightly more angled at the base than in *snowi*. Nodal cells almost as broad as long and strongly arched, second and third anteapicals long, second anteapical extending its apical width beyond the adjoining cells.

Body color pale straw, darkening on the tergum and along some of the carinae. Dark examples may have the mesonotum brown with the carinae light. Elytra milky subhyaline, a fuscous spot on the basal angle of the costa. A line on the sutural margin back of the middle and another at the apex, the stigma broadly fuscous, a smoky spot in the broad nodal cell opposite stigma and the tips of the apical veinlets fuscous. Claval areas fulvous and there is a pale fulvous band from apex of clavus across the cross-nervures to the spot in nodal cell. A fulvous or smoky cloud on the nervures at the apex of the second and third apical cells.

Holotype ♀ allotype ♂ and 16 paratypes, Buckeye, Arizona, April 16, 1933, swept from Samphire (*Salicornia sp.*) by the senior author. This species is easily recognized by the fulvous band across the elytra and the inflated costal nervure. It is no doubt the banded variety of *pellucens* mentioned by Fowler, but cannot be that species as the elytra are much broader and shorter. A single female of a larger, paler variety was taken at Calexico, California, June 10, 1931.

6. **Oecleus subreflexus** Van. D.

(Plate II, Fig. 6)

Oecleus subreflexus V. D. Proc. Cal. Acad. Sci., 4th Ser., 14: 406, 1924.
Oecleus decens Metcalf. Jour. Elis. Mitch. Sci. Soc. 38: 162, Figs. 297 and 587, 1923. (Not Stål.)

Small elongate, pale yellow with a tawny mesonotum. Length 5–6 mm., width 2 mm.

Vertex narrow, parallel margined; in profile vertex and face right angled, front broadly rounding. Elytra long, narrow, the apex angularly rounding; the veins setigerous but uncolored or only faintly dotted. Costal nervure broad around the angle but unarmed. Male genital segment shallowly excavated with a roundingly projecting base, tipped with the usual projection.

Color—Pale creamy throughout, mesonotum with a tawny cast and a slight darkening inside the outer carinae usually emphasized posteriorly.

Habitat: Collected from May to August at Yuma, Arizona, Calexico, Imperial, and Indio, California, on the giant salt bush (*Atriplex lentiformis*) by the senior author. Described from Potholes, California (V. D.) and collected at Overton, Nevada (Fox).

7. **Oecleus sagittanus** Ball & Klbg., n. sp.

(Plate II, Fig. 7)

Resembles *subreflexus* but longer and narrower with an acutely angled vertex. Pale straw, black dots on nervures.

Length ♀ 5.5 mm., ♂ 4.5 mm., width 1.8 mm.

Vertex very narrow at the base widening anteriorly; in profile similar to *centronus*, angle of vertex slightly more acute than *subreflexus*. Elytra almost three times as long as broad, nodal cell nearly twice as long as broad, moderately and uniformly arched. Male genital plate broadly but shallowly notched, a rounding or angular projection almost filling the notch and terminating in a long slender process. Costal nervure expanded towards the base.

Color—Straw, mesonotum soiled tawny, pronotum definitely lighter, face vertex and femora except apices black. Elytra milky hyaline, nervures pale, heavily dotted with setigerous punctures, stigma and tips of apical nervures broadly fuscous.

Holotype ♀ allotype ♂ and three paratypes Overton, Nevada, May 8, 1929, one paratype each Overton, July 7, Glendale, May 5, and Mesquite, July 6, all taken in Nevada by David E. Fox from the arrow weed (*Pluchea sericea*). Holotype and 4 paratypes returned to E. W. Davis from whom they were received. The spotted nervures, acute head and broad costa will readily separate this species from the other yellow forms.

8. **Oecleus planus** Ball & Klgb., n. sp.

(Plate II, Fig. 8)

Resembling *sagittanus* but shorter with a less acute head and narrow costal nervure, pale tawny, yellow with a pair of black stripes outside the outer carinae of the mesonotum. Length ♀ 5 mm., ♂ 4 mm., width 1.7 mm.

Vertex broad almost parallel margined, as broad in front as the distance it projects from the eyes; in profile about right angled with the front, front decidedly rounding especially in front of the eyes. Elytra broader and shorter proportionately than in *sagittanus* with the costal nervure not broadened before the base, the third anteapical but little longer than the adjoining cells. Male genitalia similar to *sagittanus*.

Color—Face and mesonotum pale orange with a tawny cast, the latter with a pair of heavy black stripes just outside the outer carinae, pronotum creamy with two black spots. Elytra pale tawny subhyaline, nervures pale and weakly setigerous but lacking the black spots. A few smoky lines on the cross-nervures and smoky dots on the apical margin.

Holotype ♀ Cabazon, California, June 30, 1909 (Ball). Allotype ♂ taken June 8, paratype females June 8 and July 6, 1929, at Las Vegas, Nevada. Paratype ♂ Glendale, Nevada, May 5, 1929, all recorded as swept from rabbit brush (*Chrysothamnus panniculatus*) by David E. Fox. Allotype and two paratypes returned to E. W. Davis who sent them for determination. The heavy black lines on the mesonotum and the pale elytra will at once separate this from all other species in this group.

9. **Oecleus pulchellatus** Ball & Klgb., n. sp.
(Plate I, Fig. 9; Plate II, Fig. 9)

Small, pale, golden yellow resembling *centronus* in form but lacking the broad costa. Length ♂ 4 to 5 mm., width 1.8 mm.

Vertex narrow, almost parallel; in profile slightly acutely angled with the front, front broadly evenly rounding. Elytra short, broad as in *centronus* the nodal cell much narrower; the third and fourth anteapicals about equal posteriorly, two of the four examples have an additional apical nervure. Male genitalia similar to that in *sagittanus*.

Color—Pale golden yellow, the mesonotum tinged with orange and with a pair of smoky lines between the outer carinae, nervures of elytra concolorous, the setigerous punctures scarcely marked.

Holotype ♂ and two paratype males June 23, 1929, Sacaton, one paratype Phoenix, Ariz. July 10, 1930, all collected by the senior author swept from alkaline areas where *Dondia* and similar plants grew. A strikingly distinct little species in its total lack of ornamentation. It is closely related to *minima* of Fowler but the vertex is longer and not widened apically and the elytra are more broadly rounding than in that species.

10. **Oecleus cabazonus** Ball & Klgb., n. sp.
(Plate II, Fig. 10)

Similar to *planus* in form with a longer vertex. Pale, mesonotum chestnut with tawny carinae. Length 4–5 mm., width 1.7 mm.

Vertex moderately broad, parallel; in profile right-angled with the rounding face. Elytra long, narrow, nodal cell long and narrow very slightly arched.

Color—Face tawny, the carinae lighter, pronotum pale with two and sometimes four dark spots. Mesonotum pale brown, the carinae tawny, elytra milky subhyaline with tawny margins and a tawny line

on the claval suture. The nervures are concolorous with the milky membrane and extremely closely set with tawny punctures throughout.

Holotype ♀ allotype ♂ and 10 paratypes, Cabazon, California, June 20, 1909. Swept from the desert willow (*Chilopsis linearis*) by the senior author. This species is near *subreflexus* of the same region but may be distinguished by the longer and narrow form, the narrow costa and the numerous dots on the nervures.

11. **Oecleus lineatus** Ball

(Plate I, Fig. 11; Plate II, Fig. 11)

Oecleus lineatus Ball. Can. Ent. 34: 154, 1902.
Oecleus concinnus Fowl. Biol. Centr.-Amer. Homop., 1: 91, Table X, Fig. 12, 1904.
Oecleus pellucens Van Duzee. Bul. Buffalo Soc. Nat. Sci., 10: 495, 1912. (Not Fowler.)

Long, narrow, straw-colored with at least five light stripes on the mesonotum and a long acutely angled vertex. Length 5 to 8 mm., width 2.6 mm.

Vertex extremely long and narrow only slightly widening anteriorly; in profile acutely angled with the long almost straight front. Elytra extremely long and narrow, the nodal cell only slightly longer than broad, the inner margin strongly arched. Male genital segment with a broad almost square projection following the emargination and equalling the pygofers, the process extending beyond.

Color—Front black, the carinae tawny, pronotum pale, mesonotum orange, the five carinae light, often slightly margined with fuscous. Elytra milky subhyaline, nervures closely but minutely dotted with fuscous. The stigma narrow tawny.

Habitat: The senior author has collected this species in abundance from the spiny aster (*Lygodesmia spinosa*) in June and July in the Imperial Valley, California, and from many places in the Gila River drainage in Arizona, including Yuma, Wickenburg to Apache Junction, Phoenix and Sacaton, and one example is at hand from Wells, Nevada, another from Brownsville, Texas (Snow). Fowler's description and drawings of *O. concinnus* from Mexico fit this species in every particular and the habitat given is within the range of its food plant. On examination the material Van Duzee listed as *pellucens* from Arizona proved to be typical *lineatus*. It could not be *pellucens*, because the vertex of that species is shown as short and broadening anteriorly, while the vertex in *lineatus* is long and parallel margined, but even more definite is the broad costa shown in *pellucens* which allies it with the *snowi* group and definitely excludes it from this one.

12. **Oecleus nolinus** Ball & Klgb., n. sp.
(Plate I, Fig. 12; Plate II, Fig. 12)

Resembling *lineatus* but smaller with a broad white line on the mesonotum and a long narrow nodal cell. Length 6 to 7 mm., width 2.2 mm.

Vertex no longer than in *lineatus* but broader and in profile slightly more acute at the apex with the front very broadly rounding throughout. Elytra extremely long, narrow with the nodal cell narrow, twice as long as broad. Male genitalia similar to *lineatus*.

Color—Face black, carinae light, mesonotum testaceous with a broad white median stripe and a pair of narrow tawny stripes on the outer carinae, margined with smoky. Elytra straw-colored, the veins sparsely dotted with small dark points, the apical veinlets with smoky terminations, stigma scarcely marked.

Holotype ♀, allotype ♂ and 16 paratypes from the east slope of the Santa Rita Mountains (labelled Tucson), Arizona, May 23, 1929, one paratype, July 13, 1929, and three, June 15, 1930, from Williams, all taken by the senior author on bear grass (*Nolina microcarpa*). Closely related to *lineatus* but the broad white line on the mesonotum and narrow nodal cell of this species will at once distinguish it.

13. **Oecleus perpictus** Van Duzee
(Plate I, Fig. 13; Plate III, Fig. 13)

Oecleus perpictus Van Duzee. Pan.-Pacific Ent., 5: 173, 1929.

Long, narrow, with an acute vertex and heavily maculate elytra. Length 5–6.5 mm., width 1.9 mm.

Vertex margins touching at the base and gradually widening, but not as wide at apex as the distance beyond the eyes. In profile the vertex very acute and the face almost flat. Elytra are long, narrow with a narrow costal nerve and costal area, the nodal cell nearly twice as long as wide, the interior margin moderately arched. Third anteapical exceeds the second by more than its apical width, thus shortening the apical cells. Male genital segment roundingly projecting from the base of the shallow emargination with a broad triangular projection.

Color—Face black, lateral carinae white, median carinae only appearing at the base, mesonotum black with a broad creamy median stripe and a narrow testaceous line on the outer carinae. Elytra hyaline or slightly milky, the sutural margins narrowly ivory twice interrupted with black. A line on the suture an irregular area around the anterior end of the third anteapical and all of the nervures surrounding the inner seven apical cells broadly fuscous.

Habitat: Collected by the senior author from mesquite grass (*Muhlenbergia porteri*) at Yarnell Heights, Sabino Canyon, and the Baboquivari Mountains, Arizona. Males appearing in early July, the females late in the month and on into August.

14. **Oecleus tamiamus** Ball & Klgb., n. sp.

(Plate III, Fig. 14)

Resembling *acutus* Ball (from Haiti) in the extremely long and acute head but the vertex and front are much wider, tawny with milky elytra and brown shades between the carinae on the mesonotum. Length 4.5–5.5 mm., width 1.6 mm.

Vertex touching at the base broadening apically where it is two-thirds as wide as it extends beyond the eye. In profile acutely angular with the front rounding in above the eye. Elytra much shorter and broader than in *lineatus*, much as in *subreflexus* but costal area narrower, nodal cell half longer than wide the posterior one-half definitely arched, the third anteapical exceeding the adjoining ones by less than its apical width. Male genitalia resembling *sagittanus*.

Color—Face brown shading to black, the margins and median carinae which extend throughout, tawny; mesonotum with the lateral margins and carinae fulvous on a brown background. Elytra milky, subhyaline, the nervures pale and weakly setigerous with black punctures to the anteapical cells then strongly fuscous to the apex. Stigma rather broadly black, sutural margins white, twice interrupted with black.

Holotype ♀, allotype ♂, Childs, Florida, June 10, 1928, one paratype female Sebring, Florida, July 20, 1926, all taken by the senior author. The acute head alone will separate this species from all others in the region.

15. **Oecleus excavatus** Ball

(Plate III, Fig. 15)

Oecleus excavatus Ball. Can. Ent., 34: 155, 1902.

Resembling *venosus* in the broad vertex and heavy spotting but the vertex is much longer and more acutely angled than in that species and the mesonotum shows five carinae. Length 4.5–5 mm., width 1.6 mm.

Vertex almost as broad as in *campestris* but much longer, exceeding the eyes by its own width and forming an acute angle with the front. Mesonotum with the intermediate carinae weak and decidedly irregular, almost touching the lateral carinae anteriorly and the median carinae posteriorly. Elytra long and narrow, the nodal cell long and narrow, only about twice the width of the stigma. Connections between the branches of radius and medius (the ends of the third anteapical) faint or wanting. Male genital segment emarginate with a short broad acutely angled projection which bears a stout process.

Color—Face and below black, the carinae light, pronotum straw with dusky spots in the depressions. Mesonotum dark brown, the carinae and a pair of lateral lines tawny. Elytra milky, a pair of spots on suture, the stigma and the tips of apical nervures dark. Nervures white, heavily dotted with black. Two examples from Nevada are very dark, the mesonotum being black with only the carinae narrowly light.

Habitat: Originally collected in Wray, Lamar and Fort Collins, Colorado, in June and July and examples are at hand from Doyle, California, July 21 (Ball), Glendale, Nevada, May 5, (Fox) Bunkerville, Nevada, April 17 (Davis).

16. **Oecleus venosus** Van Duzee

(Plate III, Fig. 16)

Oecleus venosus Van Duzee. Bul. Buffalo Soc. Nat. Sci., 10: 96, 1912.
Oecleus nervosus V. D. Cat., p. 737, No. 2564, 1917 (error).

Resembling *excavatus* but with a decidedly shorter and somewhat narrower vertex, black with three carinae on the pale mesonotum and heavy dotting on nervures. Length 4.5 to 6 mm., width 2 mm.

Vertex decidely narrower than in *excavatus*, almost parallel margined, extending less than its width beyond the eye; in profile right-angled with face which is strongly rounding above. Mesonotum with the intermediate carinae weak and inconspicuous. Elytra broad, relatively short, inclined to be flaring, the nodal cell strongly arched internally and nearly as wide as long. Third anteapical with nearly one-third of its length beyond junction of the adjacent cells. Male genitalia similar to *excavatus* but lacking the acute angles.

Color—Black below with only faint traces of pale on carinae. Pronotum dark with a few light spots. Mesonotum black with three carinae narrowly testaceous. Elytra with the clavus solidly smoky, a cloud in the stigmal cell and flecks on the cross-nervures and apical nervures.

Habitat: Common throughout California in June and July and specimens are at hand from Burns, Oregon (Wallace), Reno, Nevada (Ball), and Yarnell Heights, Arizona (Ball). This is a rather puzzling and variable species, intermediate in some characters between the long and short-headed groups but when typically colored can be distinguished by the three carinae.

17. **Oecleus borealis** Van Duzee

(Plate III, Fig. 17)

Oecleus borealis Van Duzee. Bul. Buffalo Soc. Natur. Sci., 10: 495, 1912.

A dark smoky species resembling *venosus* but slightly larger with all five carinae showing and the elytra uniformly pale smoky. Length 5–6 mm., width 1.8 mm.

Vertex slightly wider anteriorly than in *venosus*. In profile right angled with a more definite angle in the face. Elytra shorter and broader than in *venosus*, the nodal cell longer with a much smaller stigma. Male genitalia similar to *decens* in pattern but with the lateral spines enlarged to form a rectangular basal area.

Color—Dull smoky, face black, with light carinae, mesonotum tawny with black stripes inside the lateral margins and another pair inside the outer carinae. Occasionally all the disc is dark except the

carinae. Elytra smoky, nervures pale before the anteapicals, smoky beyond, and nervures finely dotted with brown which does not show on the smoky portion.

Habitat: Examples have been examined from the District of Columbia and many places in Florida (Ball), several places in Mississippi (Drake) and it has been reported from New York and New Jersey. It has been taken throughout the season and probably hibernates as an adult.

18. **Oecleus quadrilineatus** Van Duzee

(Plate III, Fig. 18)

Oecleus quadrilineatus Van Duzee. Bul. Buffalo Soc. Nat. Sci., 10: 496, 1912.

Large dark, resembling *borealis*, but larger with four broad yellow lines on the black mesonotum, nervures without punctures. Length 5.5–6.5 mm. Width 2.2 mm.

Vertex narrow at the base expanding apically where it is wider than its projection beyond the eyes, about equalling *borealis*. In profile about right angled with face which is slightly angled in front of the eyes. Elytra about as in *borealis*, the nodal cell broader and the stigma more prominent. Male genitalia similar to *borealis* but with the styles turned up into the cavity.

Color—Black with subhyaline elytra; face and below black with the carinae faintly testaceous; mesonotum black with four broad testaceous stripes the two outside the carinae short; nervures pale smoky becoming broader and darker apically very faintly and irregularly punctured; stigma large, dark.

Habitat: Eight examples were swept from golden currant (*Ribes cereum*) in Granite Dells on July 17, (Ball), one example was taken July 4 in the Chiricahua Mts. (Ball) and Van Duzee described it from the Huachuca Mts. All high mountain ranges in Arizona.

19. **Oecleus campestris** Ball

(Plate I, Fig. 19; Plate III, Fig. 19)

Oecleus campestris Ball. Can. Ent., 34: 156, 1902.

Resembling *decens* but with the vertex nearly twice as wide and the nervures dotted throughout. Black below, mesonotum lined with tawny, elytra milky. Length 5–6 mm. Width 1.9 mm.

Vertex broad, parallel margined, less than twice as long as its median width, scarcely exceeding the eyes in length. Pronotum very broad with a definite angulate emargination posteriorly. Mesonotum with five carinae, the intermediate ones weak and curving outward anteriorly. Elytra relatively broad and short, the costal nervure but little thickened, the nodal cell nearly twice longer than broad and but little arched. The third and fourth anteapicals of approximately equal length and only slightly exceeding the adjacent cells posteriorly. Male genitalia similar to *decens*.

Color—Face and below dark brown with all carinae pale. Pronotum straw colored with a few fuscous dashes. Mesonotum testaceous with the five carinae and two stripes on either side pale. Elytra milky subhyaline, nervures white, finely dotted with fuscous, often the apical nervures and the stigma smoky, sometimes a pair of smoky lines along the middle of the suture.

Habitat: Described from Lamar, Colorado, where it was taken in abundance by the senior author June 17 feeding on the sand binding sage (*Artemisia filifolia*). One example was taken at Roosevelt Dam, two on the slopes of the Santa Rita's, and six on the Chiricahua Mountains in Arizona. The broad short vertex will instantly separate this species from all related forms.

20. **Oecleus decens** Stål

(Plate I, Fig. 20; Plate III, Fig. 20)

Oecleus decens Stal. Ber. Ent. Zeit., 6: 307, 1862.
Oecleus obtusus Ball. Can. Ent., 34: 155, 1902.
Oecleus productus Metcalf. Jour. Elis. Mitch. Sci. Soc., 38: 184, 1920.

A large dark species resembling *campestris* but with a narrower vertex which is closed posteriorly and the nervures are obscurely pustulate. Length 5–7 mm., width 2 mm.

Vertex three times as long as its median width, closed posteriorly, scarcely exceeding the eye in length, in profile meeting the front in an obtuse angle, front again angled before the eyes. Mesonotum with the median carinae straight. Elytra, about as in *campestris*. Male genital segment with a very shallow emargination from the base of which projects a large triangular tooth with slight projections on the lateral margins.

Color—Face and below black, pronotum smoky with lighter margins, mesonotum dark testaceous with about nine fulvous lines, elytra milky with pale nervures finely but obscurely dotted, nervures on apical half smoky with the punctures scarcely visible. In dark specimens all nervures are smoky.

Habitat: Occurs in abundance on various trees and bushes throughout California, Arizona and adjacent Mexico, and examples are at hand from various places in Utah, Colorado, Nebraska, Kansas, Southern Illinois, Mississippi, Texas, and it has been reported from New Mexico (Van D.).

Stal described this species in 1862 from a female from Mexico, the only diagnostic characters being a length of 7 mm. General dark color with yellowish testaceous carinae and markings. The elytra "vitreis" the veins on basal part punctate, on apical part dark. No mention is made of the length of vertex. Early authorities determined the common southeastern species as *decens*, and with this in mind the

senior author described the western form as *obtusus* (1902). Fowler in the Biologia (1904) lists and figures as *decens* a large broad-winged yellow species with a long narrow vertex and the nervures granulated throughout. This from the enlarged costa and the male genitalia is no doubt *snowi* but cannot be *decens* of Stal in size, color, or granulations. Later with more material available Van Duzee determined that the distribution and characters of the southwestern form were much nearer to those of *decens* than that of the southeastern one and named the latter *borealis*. This has been accepted and followed by all except one of the later workers.

Metcalf in 1923 further complicated the situation by keying out and figuring a species with a long vertex as *decens*. The male genitalia and head characters shown resemble those of *subreflexus*, a small golden yellow species which cannot possibly be what Stal described. The figures are evidently inaccurate as they show acute lateral projections on the anal segment and forking carinae on the mesonotum, characters not found in the genus. He then describes *productus* from southern Illinois and Arizona. The authors have examined a paratype from Metropolis, Illinois, and found it to be a small pale example of *decens* with the apical nervures pale and the dots showing—a variation often found in Kansas, Mississippi and Texas specimens. The male genitalia of the paratype are of the typical broad triangular form with lateral points and not at all as shown in his figure which must have been from a distorted example.

21. **Oecleus fulvidorsum** Ball

(Plate III, Fig. 21)

Oecleus flulvidorsum Ball. Can. Ent., 34: 157, 1902.

Light creamy yellow with a milky elytra much narrower than in *decens*. Length 4–5 mm., width 1.7 mm.

Vertex very narrow at base slightly widening apically, short scarcely exceeding eyes. In profile joining the front at an obtuse angle so that the outline almost parallels the curve of the eyes. Elytra rather long and roundingly compressed so as to give the insect a much narrower and more parallel appearance than *decens*. Venation simple, regular, with the nodal cell long and only slightly arched. Male genital segment with a long terminal tooth, one-third the width of emargination.

Color—Creamy throughout, the clypeus orange, mesonotum tawny with the carinae paler. Elytra creamy translucent, the nervures concolorous and obscure on the basal half, thickly dotted with fine fuscous points and tipped with smoky toward apex. Two pairs of short lines along the commissure in the darker examples.

Habitat: Taken by the senior author in many places in Colorado, California, Utah and Arizona on the winged salt bush (*Atriplex canescens*) from May to July. Examples have been examined from Nevada (Fox). Like its host this is a widely distributed and common insect. The uniform pale creamy shade alone will ordinarily distinguish it.

22. **Oecleus monilipennis** Van Duzee

(Plate III, Fig. 22)

Oecleus monilipennis Van Duzee. Calif. Acad. Sci., 12: 190, 1923.

Form and structure of *fulvidorsum* nearly. Pale tawny to smoky with a pair of black lines bordering the outer carinae of the mesonotum, the elytra heavily maculate. Length 4.5–5.5 mm., width 1.7 mm.

Vertex rather narrow almost parallel margined, in profile as in *fulvidorsum*. Elytra about as in *fulvidorsum* except that the apices are noticeably curved downward and the pustules are much heavier throughout. Male genitalia similar to *fulvidorsum* but the tooth much broader, as broad as long.

Color—Face pale or pale-smoky, the clypeus orange, the pronotum with four oblique stripes which are continued as oblique stripes margining the outer carinae of the tawny or orange mesonotum. Elytra smoky subhyaline with the white nervures studded with large heavy setigerous black punctures. The cross-nervures, the whole apical margin, the scutellar margin, and a pair of spots on the suture smoky to black. In light specimens the general color is more creamy with a single pair of mesonotal stripes and the spots on the elytra are much reduced.

Habitat: Taken by the senior author on *Atriplex polycarpa* at Tucson, Sacaton and Yuma, Arizona, St. George, Utah, and Port Libertad, Sonora, Mexico. Examples are at hand from Glendale, Nevada and Van Duzee described it from the Gulf of California region. This beautifully marked species is abundant especially in alkaline regions and when its food plant dries up may be found on the giant Atriplex or even on Sea blite (*Dondia*).

23. **Oecleus piperatus** Ball & Klgb., n. sp.

(Plate I, Fig. 23; Plate III, Fig. 23)

Smaller and more slender than *fulvidorsum*. Pale with two black lines on the orange mesonotum. Elytra milky and sparsely dotted. Length 3.5–4 mm., width 1.2 mm.

Vertex very narrow and almost parallel margined scarcely more than a line throughout. In profile definitely, but slightly obtusely angled with the rounding front. Elytra long and narrow, exceptionally narrow at the base. Male genitalia similar to *fulvidorsum* except the lateral margins shorter.

Color—Face pale shading to orange below, the vertex pale, pronotum pale with two oblique lines which are continued as narrow black stripes outside the carinae of the fulvous mesonotum. Elytra strongly milky, the nervures white with sparse but rather large and distinct black dots throughout. Four spots on the commissure, the tips of the apical nervures black.

Holotype ♀ allotype ♂ and 7 paratypes, Tucson, Arizona, July 24, 1930 and 12 paratypes Sacaton, Arizona, July 23, 1931, all taken by the senior author on *Atriplex linearis*. The small elongated form with the heavy dotting on the elytra is quite distinct in the group.

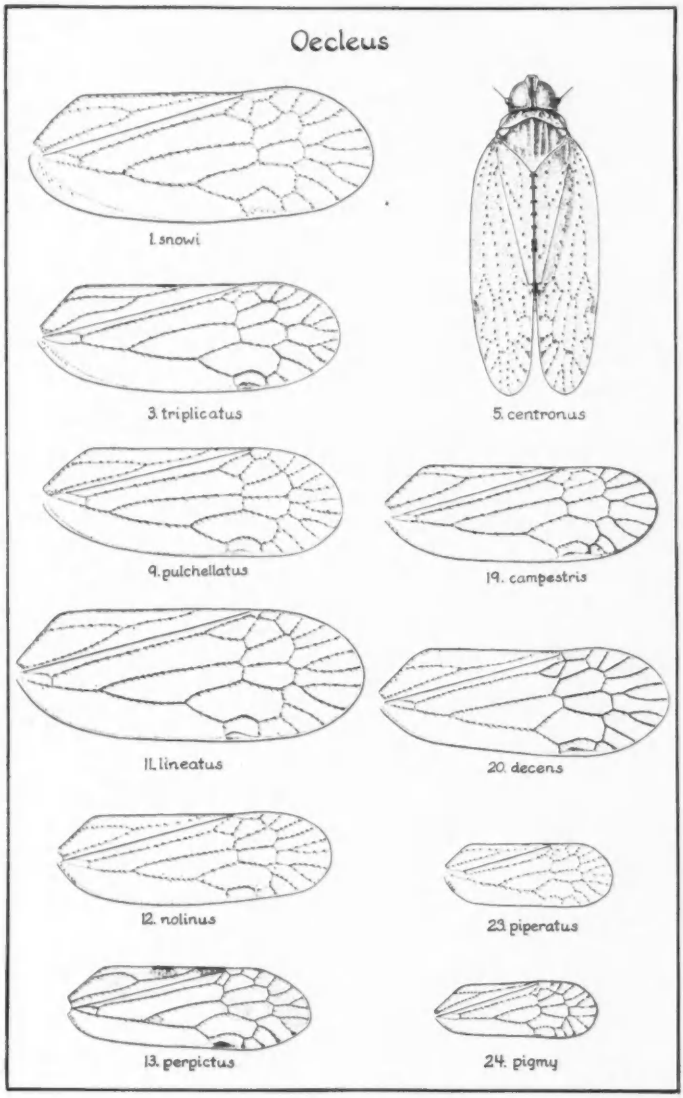
24. **Oecleus pigmy** Ball & Klgb., n. sp.
(Plate I, Fig. 24; Plate III, Fig. 24)

Form of *fulvidorsum* but little more than half the size, a short, stout slate-blue species with heavy black nervures. Length 3–3.5 mm., width 1.3 mm.

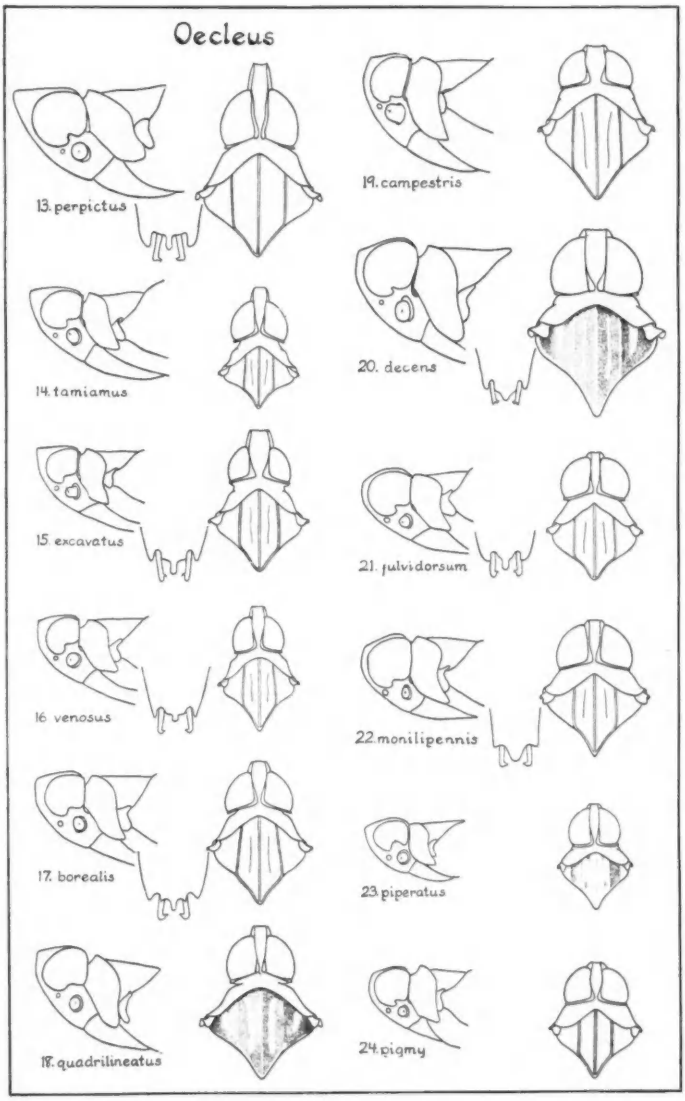
Vertex broadening anteriorly, only just exceeding the eyes; in profile but slightly deviating from the curve of the eyes. Mesonotum with three carinae emphasized and two reduced and irregular. Elytra about as in *fulvidorsum*, the posterior ends of the anteapical cells forming a parabola the nodal cell very narrow and little arched. Male genitalia intermediate in character between *fulvidorsum* and *monilipennis*.

Color—Face and below slaty with the carinae broadly light yellow, pronotum creamy with four faint spots. Mesonotum slaty with a fulvous tinge. The three major carinae broadly light, usually with faint lines between and outside. Elytra smoky with a milky blue overcast, the nervures broadly smoky brown the setiguous punctures masked.

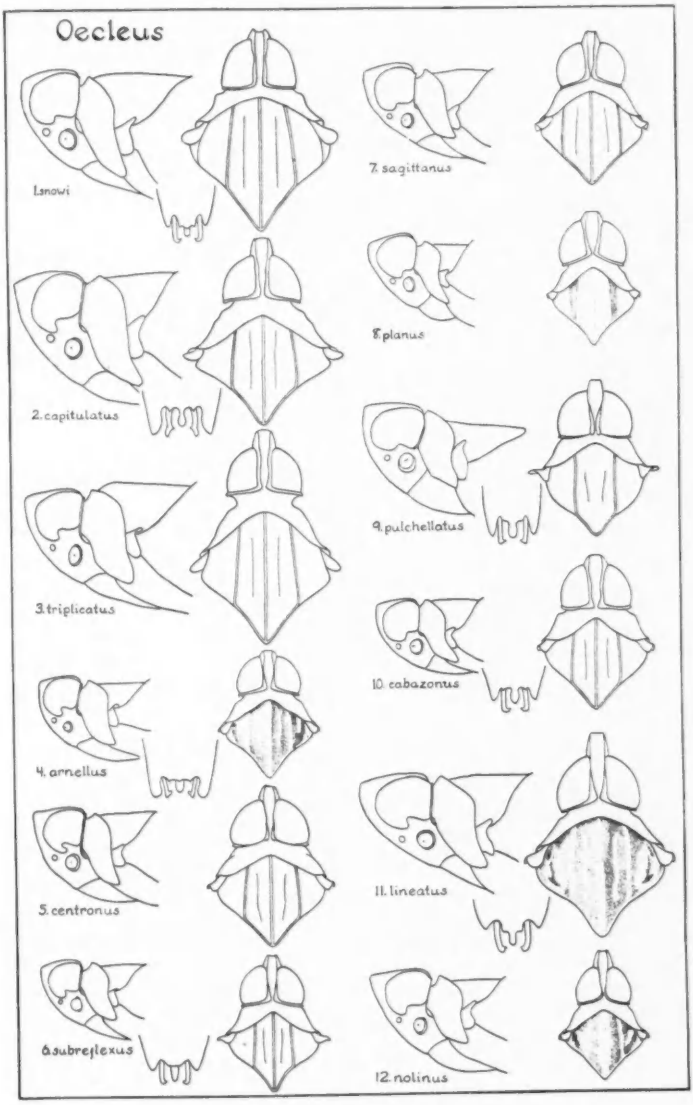
Holotype ♀, allotype ♂, and 16 paratypes taken by the senior author on the low shrubby salt bush (*Atriplex linearis*) at Sacaton, Arizona, April 2, 1932. Other examples are at hand from Idaho, Utah, Nevada, and Southern California.



Wing types in Oecleus



Structural characters in Oecleus



Structural characters in Oecleus

TWO NEW SPECIES OF NORTH AMERICAN STRUMIGENYS

(Formicidae: Hymenoptera)

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In a revision of the North American ants of the genus *Strumigenys* (Annals Ent. Soc. Amer., Vol. 24, pp. 686–710, 1931) I listed 16 species for this country. Two additional species have since been described, *ohioensis* by Kennedy and Schramm, and *talpa* by Weber. This paper adds two more, making 20 species for America north of Mexico.

Both of the species herein described belong to the *clypeata* group, as is evidenced by the shape of their clypeus and other characters.

One of the new species, *brevisetosa*, was collected by H. L. Dietrich, at Lucedale, Miss.; the other, *rohweri*, was collected by L. C. Murphree at Holly Springs, Miss., while he was scouting for Argentine ants for the Bureau of Entomology. The latter species is named in honor of S. A. Rohwer, Assistant Chief of the Bureau, under whose supervision the Argentine ant scouting work was done.

Strumigenys (C.) rohweri, sp. nov.

Worker.—Length, 2.3 mm.

Head, although gradually narrowing anteriorly, not so pronounced in the region of the clypeus as in *Str. clypeata*. Clypeus very broadly and bluntly rounded, almost subtruncate in appearance when viewed anteriorly. Mandibles moderately prominent, convex, each with five distinct teeth and some smaller apical denticulae, the third tooth clearly the longest; a great deal of the base of the mandibles obscured by the clypeus, which projects above both anteriorly and laterally. Antennal scapes moderate in size, not angulate basally. Eyes rather small, oval, moderately convex. Thorax similar to that of *Str. clypeata*. Epinotal spines acute, each with a narrow, thin, infraspinal lamella beneath. Ventral and posterior surface of the petiole and practically all but the dorsal surface of the postpetiole with the usual spongiform processes.

Head, thorax, and postpetiole reticulate-punctate, subopaque. Mandibular teeth, region in area of frontoclypeal suture, pleurae of

meso- and metathorax, dorsal surface of postpetiole, and gaster, smooth and shining. On some specimens there is a faint median thoracic carina running anteroposteriorly.

Clypeus covered with abundant, very closely appressed, short, spatulate hairs, which almost entirely obscure the general surface. Hairs on the remainder of the head longer, curved, and less spatulate, tending more to clavate. Dorsal surface of thorax, petiole, postpetiole, and both dorsal and ventral surfaces of the gaster with extremely long, simple hairs.

Light to dark ferruginous; mandibular teeth and first gastric segment darker, appendages lighter. Clypeus of a grayish appearance because of the nature of its pilosity.

Str. rohweri bears such a striking resemblance to *Str. clypeata* that the two might easily be confused. This new species is distinguished by the following characteristics of the worker: (1) Its very broadly rounded, somewhat truncate-appearing clypeus; (2) the shape of the mandibles as well as the arrangement of the teeth; and (3) the very strikingly spatulate hairs of the clypeus. Of the characters mentioned, the shape of the clypeus and the nature of the pilosity of the clypeus and head are most apparent.

Type locality.—Holly Springs, Mississippi (L. C. Murphree).

Described from eight workers, the cotypes of which are in my collection and that of the United States National Museum. The colony from which the cotype specimens came consisted of approximately 75 to 100 workers and a number of dealate queens, all of which were nesting in the soil beneath a rock.

Strumigenys (C.) clypeata brevisetosa, var. nov.

Worker.—Length, 1.3–1.5 mm.

Head, including mandibles, rather long and slender, converging toward the apices of the closed mandibles. Clypeus broadly and evenly rounded, gradually fusing into the sides of the head without any definite limits. Mandibles approximately one-fifth the length of the entire head; each with five well defined but not strikingly large teeth, the third of which is apparently the longest, and several apical denticulae. Antennal scapes moderate in size, not angulate basally. Mesoepinotal suture visible, but the region in that vicinity not strongly constricted. Epinotal spines acute, each with a narrow, thin, infraspinal lamella beneath. Ventral and posterior surface of the petiole, and practically all but the dorsal surface of the postpetiole, with the usual spongiform processes.

Head, thorax, and petiole reticulate-punctate, subopaque. Mandibles, clypeus, frontal area, pleurae of meso- and metathorax, dorsal surface of postpetiole, and gaster, smooth and shining. Thorax with a faint median carina running anteroposteriorly.

Clypeus with very short, curved hairs which are enlarged apically, those on the front and lateral borders of the clypeus directed more anteriorly; hairs on the remainder of the head sparser, longer, curved, and not so much enlarged toward their apices.

Dark ferruginous; mandibles, clypeus, appendages, spongiform processes, and tip of gaster lighter.

This new variety belongs to the *clypeata* group, which at present includes the species *clypeata* and its varieties *pilinasis* and *laevinasis*. The characteristics which distinguish the worker of *brevisetosa* are: (1) The broadly and evenly rounded clypeus, the surface of which is glabrous; and (2) the short, curved, and apically enlarged hairs of the clypeus.

Type locality.—Lucedale, Mississippi (H. Dietrich).

Described from a single worker, the type of which is in my collection. The single specimen was taken by Mr. Dietrich while sifting for beetles.

THE WOOD-FEEDING ROACH CRYPTOCERCUS, ITS PROTOZOA, AND THE SYMBIOSIS BETWEEN PROTOZOA AND ROACH, by L. R. CLEVELAND in collaboration with S. R. HALL, E. P. SANDERS and JANE COLLIER. Mem. Amer. Acad. Arts and Sciences, Vol. 17, No. 2, pp. i-xx and 185–342, Plates 1–60. 1934. Price, $6.50.

This remarkable quarto volume with over half its thickness in beautifully executed heliotype plates summarizes Cleveland's work on this very primitive wingless cockroach. As an outstanding authority on the symbiosis between Hypermastigina and the termites he has had grants for the work from four funds and considerable help from various specialists. It is such co-operative help that makes extensive research possible.

Cryptocercus is abundant in wet rotten logs all through the humid parts of the Central Allegheny region from southern Ohio to Virginia. The reviewer found it in every such spruce log on the crests of the Great Smokies. It is interesting, first, because it has a family life, the two parents always being found in the same burrow with the young of one or several seasons; second, because it eats wood and its hind intestine is gorged with the large ciliate Protozoa of the Order Hypermastigina which are found only as symbionts in the termites and in this roach. Cleveland has examined all other available wood-eating insects but finds that this order of Protozoa are thus limited. The wood is digested by the Protozoa. The products of digestion then pass forward into the stomach where they are absorbed.

In the body of the work largely devoted to the anatomy of the Protozoa much interesting information is given on the nuclear processes during cell division. The study has thrown much light on such cytological problems.

Cleveland points out that because the Hypermastigina are known only from this roach and the termites that the two are probably descended from a common ancestor in the Protoblattoidea, that this must be one of the very primitive of living insects.

Altogether this is a magnificent work and we envy any man who can accomplish as much in five years.—C. H. K.

THE SENSE ORGANS UPON THE DORSAL SURFACE OF THE FEMALE BLACK SCALE, SAISSETIA OLEAE (BERNARD) (Coccidae, Homoptera)[1]

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There are four types of sense organs upon the dorsal surface of the female black scale, these will be described separately in this paper. If we except the attempts made to find the number and distribution of these organs upon the body, the entire work was done by means of sections, in nearly all of these the body of the insect was cut transversely. In studying the glands upon the insect's body and in an attempt to work out the development and structure of the ocelli, a great many scales were sectioned. These slides formed the basis for this work but many other insects were sectioned, especially for this paper. With the exception of several other stains the technique has been described in the other papers.

THE DORSAL SETAE

By far the most numerous of all the sense organs of the female black scale are the small, sensory setae scattered over the dorsal surface. These form a very simple example of a trichoid sensillum; a small seta, a nerve cell, either intrahypodermal or subhypodermal in position, connected by a small nerve to the central nervous system and, distally, extending to the base of the seta. The seta fits into a cup-like pit, the alveolus; this is raised slightly above the cuticular surface and is connected to the main cuticula by an articular membrane which gives to the seta a ball and socket movement.

No definite arrangement of these setae upon the insect's body could be determined, they were very numerous and not easily seen in a whole mount. Glandular pores are always abundant upon the dorsal surface and this adds to the difficulty of discovering any definite setal arrangement. In some specimens the distal part of the nerve cell penetrated a small opening in the cuticula, others were located within the cavities which are so plentiful in the dorsal body wall. In such cases other tissue and secretions obscured the trichogens and made it difficult to locate these cells with any certainty.

The nerve cell of these dorsal sense organs contains a single large nucleus; its terminal strand, a simple distal prolongation of the cell, extends to the base of the seta into which it was never seen to penetrate.

[1]I wish to thank Prof. H. J. Quayle of the University of California for his kindness in sending me material for this work.

Along the margin of the terminal strand some specimens showed one or two nuclei (Fig. 3, Neu. N.), these could be named as nuclei of the neurilemma. The terminal strand also showed a thin membrane along its margins; sometimes this was colored, in other specimens unstained. This covering could be the neurilemma or the secretion from a trichogen extending to the base of the seta. The alveolus was of a darker yellow than the other parts of the cuticula.

In most speciemens the sense cell was surrounded by the regular hypodermis but in some it was subhypodermal in position. This might be due to the size of the hypodermal cells which increase greatly with the thickness of the cuticula but when the insect becomes quite old the length of these cells decreases. The two figures of this dorsal sense organ have been drawn to the same magnification; it will be noticed that in one the cuticular is much thicker than in the other but that the width of the hypodermis is about the same, although one specimen shows the sense organ well below this layer of cells. (Figs. 2 and 3).

THE MARGINAL SETAE AND SENSE ORGANS

These will be divided into two groups, not that the structure of these sense organs is different but their distribution upon the insect's body is not the same. The single marginal setae are widely distributed along the edge of the scale insect, the multiple setae are present in only two pairs and their location is restricted and definite. The single marginal sensilla have a single nerve cell and but one seta, the multiple sensilla are always represented by one large and two smaller ones. Each seta forming the multiple group has but a single nerve cell, all lie close together and form a group by themselves.

Single marginal setae—These trichoid sensilla are present from near the anterior tip of the body to the corresponding position at the posterior end. They are scattered along the entire margin but their exact number is not known. These setae are readily seen in an examination of whole mounts but, in such specimens, there was always evidence of some having been broken off; if an entire seta had been removed it was difficult to find a record of its presence. In the younger insects these single setae are quite small and between thirty to fifty are present on each side of the body. They are curved near their tip which is directed towards the posterior end of the body. When the scale insects grow larger the cuticular covering changes to a darker brown and becomes honeycombed by the large cavities which always appear in this external layer of the insect's body (5). When this happens the setae become darker and many of them larger but they still possess curved, posteriorly directed tips. The single marginal setae in the older insects are of two sizes, the smaller ones are all of the same size but the larger are about one-third longer than the others. The larger and the smaller setae appear to alternate with each other but it was impossible to decide whether or not this was a definite arrangement. One could, in the case of a broken seta, see the alveolus and be sure that a seta had been present; even this was uncertain as this basal part might be hidden by the curved surface at the margin of the insect's

body. There were at least twice as many of these single marginal setae on the old scale insects as upon the younger ones.

The structure of these sense organs (Fig. 4) is very similar to that of the dorsal ones. There is a single uninuclear nerve cell, subhypodermal in all specimens examined, from which a nerve extends inward from its proximal end, and a terminal strand from the nerve cell to the base of the seta. In no instance was an extension of this strand into the seta observed. The seta of a marginal sense organ (Fig. 5) is considerably longer than that of those upon the dorsal surface. From their greater length it was difficult to find a section showing both the nerve cell and the entire seta and to show the relative size of these two parts it was best to figure them separately (Figs. 4 and 5).

Multiple marginal setae—These, in contrast to the single ones, are limited in number and always found in the same position upon the body. There are only two pairs and they are located near the regions dividing the body of the insect into its three parts. A transverse line connecting the most anterior pair would pass a little in front of the base of the first pair of legs, a transverse line connecting the posterior pair would pass a little anterior to the base of the third pair of legs. In examining a whole mount of a black scale one sees, by following along the margins from the anterior to the posterior end, that on each side and opposite to each other are two pairs of notches; sometimes these are quite deep but they are not easily seen on the largest and oldest specimens. An examination of these notches with a high power will show three setae in each depression. One of the three setae is longer and thicker than the other two both of which are of the same length and thickness. There is always a single large seta and two small ones, exceptionally three have been seen, and the smaller ones are situated one in front of and the other posterior to the large one; they are also a little dorsal to it. Both kinds of these setae are hollow and pointed, rather bluntly, and each has a closed apical end. Each has an alveolus at its base and is freely moveable.

The nerve cell of a large marginal seta (Fig. 6, N. C.) contains a single, relatively large nucleus in its basal part, and has a terminal strand extending distally to the base of the seta. A few specimens showed a nerve extending from the proximal end of the cell into the body of the insect. It was impossible in the same section to find a nerve cell and complete seta so they have been figured separately (Figs. 6 and 7). The shape of the nerve cell differed considerably in the specimens examined. Situated at the lateral margin of the insect's body, these cells were in a position where the dorsal and ventral cuticular walls were often close together and gave but little room for such a large cell. If space was ample this nerve cell assumed a more or less spherical form, if the space was limited the cell was elongated. This change in shape would also tend to alter, somewhat, the form of the large nucleus. Several of these nerve cells showed a distinctly fibrillar structure, the fibrils extending from the outer surface of the nucleus through the cell and, sometimes, they could be traced into the terminal strand. A very few of these nerve cells showed a clear tubular part extending from near the nucleus, through the terminal

strand, to the base of the seta. This was so distinct that it had the appearance of a duct leading to the base of the seta, the free end of which, however, was closed. This gives to some of these cells the appearance of the trichogen figured in the sensilla of a number of insects.

MARGINAL SENSE ORGANS

The sense organs of the third type are more peculiar in their structure than those already described and, in reviewing the literature on the sense organs of insects, nothing was found exactly the same as the ones under discussion although quite similar ones have been recorded. These sense organs in their position upon the body are not as marginal as the single and multiple setae. They are on the dorsal surface very near the margin and will be spoken of as the marginal sense organs in contrast to the next group which are more median in position. The number of these sense organs upon the body differs and it has been impossible to find the same number in very many specimens. Not only was this individual difference noticeable but the right and the left sides of the same individual did not always have the same number. In the drawing (Fig. 1) which shows the position of these sense organs upon the body, six is given as the number found on each side. The most constant number is five or six; this is true when counting on one side of the body only, five or six on both sides occurs but seldom, whereas, five on one side and six on the other, is found oftener than any other combination. Ten out of seventeen specimens examined had six of these sense organs present on one side or the other. Two individuals showed four on one side, one showed seven. When the same number is present on both sides of the body these sense organs are paired and, as to distance from either end of the body, the two forming one pair are similarily situated. Their general position might be described as follows: two pairs near the posterior end of the body and often one or two pairs slightly anterior to these, one on each side between the multiple marginal setae and one pair in front of these. These sense organs are more abundant on the posterior than on the anterior half of the insect's body.

One way in which the number of these sense organs could be ascertained was an examination of serial sections—this was a very slow method. Normal whole mounts were of very little use as the internal organs of the body, especially the muscles, made it difficult to see the sense organs. A number of scale insects were treated with KOH, cleared and mounted in Canada balsam; the dorsal surface was examined and the sense organs counted with a fair degree of accuracy. However, even in this way, one never was sure that all had been counted.

One might call the end organs of these sense organs being described as acorn-shaped (Fig. 10) were it not that different oak trees produce acorns quite different in form; this, however, is a fair description of their general outline. They are embedded in the cuticula their tip being the only part protruding beyond the surface. The end organ is divided into two parts; a proximal portion which is much the larger, and a smaller, distal, part which is only a continuation of the basal

portion. These two parts are separated from each other by the roof of the dome. The larger and dome-like part will be considered first. This is circular in transverse section. In longitudinal section the general appearance is somewhat ovoid in outline with the diameter fairly equal throughout although at the basal end it is generally thicker than at the apical part. The proximal end is entirely open and into it the terminal strand of the nerve enters, the apical end is closed by a slightly convex, cuticular membrane, the top of the dome, from which originates or through which passes the small terminal hair.

As already mentioned there are two parts of the end organ, a basal dome-like structure and a smaller apical portion which is placed upon the center of the dome. This apical part is shaped like a deep, open pill box circular in transverse section and slightly tapering at its distal end. Within this distal portion of the end organ is a duplicate structure similar in general shape but smaller. This is circular in outline and it rests upon the outer surface of the dome; it is open at its distal end. Through the center of it, arising on or just below the dome, is a small terminal hair which extends to the open end of that portion of the end organ surrounding it.

It is difficult to describe the contents of the larger, basal, part of the end organ (Figs. 9 and 10). Nearly all the sections studied were cut transversely through the body of the scale insect and one might suppose that the structure would be similar in all the slides, this was not so. Two internal parts were present in these end organs although both were not seen in all specimens. Towards the distal part of the larger basal portion was a small, stained body equally distant from the sides. In some of those insects examined the terminal hair extended through the membrane forming the roof of the dome to come in contact with the colored spot and in a few specimens it appeared to be split at its proximal end and each part to partially encircle the colored spot. More noticeable was another structure; it was cuticular, never stained and always presented a glistening appearance. This part was attached to the top of the dome and extended, slightly curved, down into the cavity where, a little beyond the middle, it ended in a knob. The ending of the nerve cell within the organ did not appear the same in all specimens, in some it was attached to this cuticular structure, in others it terminated at the colored sport. Such a splitting of the termin strand was not always seen but probably both these parts within the end organ are innervated by the distal part of the nerve cell.

These marginal sense organs are unicellular. The nerve cell has a large nucleus near its base and is surrounded by the regular hypodermal cells. It extends through an opening in the cuticular wall of the insect's body to the end organ with two parts of which it is connected by the terminal strand. The basal part of the sense cell may be sub-hypodermal but no specimen showed this cell entirely below the hypodermis. Not always do the nerve cells of these sense organs show a fibrillar structure but such an arrangement is common and, each of the fibrials seen in a longitudinal section of the nerve cell, appears to arise near the distal or outer margin of the nucleus and extends to the basal part of the terminal strand.

THE MEDIAN SENSE ORGANS

As already mentioned these sense organs are not strictly median in position but they are found nearer this part of the body than the margin; all are on the dorsal surface, on the posterior half of the insect, and nearly all are anterior to the anal opening. Figure one will give their location but this is only for a single specimen as all those examined showed a considerable variation in position on the body as well as in actual number; the former variation was much the greater. The figure also shows that these organs form an irregular group and that most of them are situated to the left of the median line. Drawings were made showing the location of these sense organs on several specimens, some showed a larger group on the right than on the left side. Their number showed individual differences, when counted upon several specimens it was found that the maximum number was thrity, the minimum number twenty-six. In exact location and in number there are individual differences.

These sense organs (Fig. 12) are larger than any of the others; the end organ is not much different in size from that last described but the nerve cell is larger and, in the old insects, it is always subhypodermal. Figure 1 shows that some of these organs are separated, others close together. This is also noticeable in the sections as a grouping of the sense cells adjacent to each other occurred in every series of sections. Two touching each other was often observed (Fig. 13) and as many as four of these sense cells packed close together would often be found. In this respect and in their general appearance they are very similar to sense organs found on the wings of *Dytiscus marginalis* (4).

The nerve cell is large with a single nucleus. In the older specimens the nucleus is often elongated and sometimes bent and in some sections it had the appearance of being in two pieces. The distal portion of the cell passes nearly through the cuticula generally occupying one of the large cavities so numerous in the cuticular covering of the older insects. This neck of the nerve cell is quite wide and never assumes a strand-like appearance. The most characteristic part of nearly all these nerve cells was their fibrillar appearance, the fibrils are very distinct and occupy most of the cell (Fig. 12).

In a large majority of sections the fibrils arise along the distal, outer, surface of the nucleus and extend to the base of the end organ which they were never seen to enter. In several of these cells the fibrils were so numerous that they nearly filled it and, when these and the nucleus were taken into consideration, there was not much left within the cell. Some cells showed the fibrils as coming directly from the nucleus but this appearance was due to their being either above or below it. Others of the sense cells showed the fibrils along the basal surface of the nucleus so that they appeared to surround it (Fig. 15). The nerve of the sense cell was not seen in many specimens but never could the fibrils be traced into it although, in one specimen, they were seen near its origin.

A fibrillar structure is not uncommon in the sense cells of insects and has been well represented by Schwabe (11) in the tympanal organs of some of the Orthoptera. In one of his figures he shows that the

fibrils unite and pass out into the nerve. He also figures the fibrils in the distal part of the cell as uniting into a single strand, this did not occur in the nerve cells of this median sense organ of the black scale as, in this insect, the fibrils remained separate and could be traced as far as the base of the end organ, never into it.

In nearly all specimens of the female black scale the fibrils remained unstained. They appeared as clear, glistening, thread-like rods undifferentiated throughout their entire length. Some were wider than others but no other variation was seen. An effort was made, by the use of many different stains, to locate some structure that would correspond to a sense rod, no such structure could be found. In looking over some of the sections for the first time a row of dots was seen crossing the neck of the nerve cell. Later it was found that these were only the ends of fibrils which had been cut obliquely and that the cut ends appeared darker than when the fibril was seen in a longitudinal view.

There is very little to describe in the end organ of these campaniform sensilla. The shape is well shown in the figures and differs only in that some are a little more elongated than others. The wall of the dome was fairly thick. Hundreds of these end organs were examined in a vain effort to find some internal structure, it was natural to suppose that such would be present. Now and then an end organ would show a median dot or rod but no doubt these were all artifacts as a similar structure could not be found with any regularity, in fact most of these were present in only one or two specimens. Just within the wall and adjacent to it could be seen, in some specimens, a layer without any definite structure but varying somewhat in thickness. This was present in several different insects but not at all common and might be due to some one of the preserving fluids used. The dome in some specimens was partially darkened, in others clear. This was due to some being seen in surface view, others in section.

Teodoro (14) has figured from the black scale these same median sense organs, he described them as "glandule perianali"; in a later paper (15) he copied the figure given in the first one. He gives the position of these glands as in a group anterior to the anal valves and so, from both their structure and position, they are the same as the median sense organs just described. When working on the dorsal glands of the black scale, Marshall (5), these structures were noticed and studied and the conclusion reached at that time was that they were sensory, not glandular. For this reason they have been described in the present paper. Teodoro in his figure of these "glandule perianali" shows a rod-like structure passing longitudinally through the greater part of the neck of the nerve cell, this structure could not be found.

There has been no intention of including any sensory structures, if such there be, on the ventral surface of the black scale. There are, however, on this lower surface some very small trichoid sensilla and these were often seen near the margin of the insect's body. One of these has been figured, (Fig. 16), and it will be noticed that it is much smaller than any of the dorsal or marginal sense organs. These small ventral sensilla are quite similar to the dorsal sense organs except that all of the parts are smaller.

SUMMARY

In briefly describing the sense organs found upon the dorsal surface of the female black scale they have been treated separately as of four types. The first and most numerous are the small, dorsal, trichoid sensilla scattered irregularly over the entire dorsal surface. Each consists of a uninuclear nerve cell connected distally with the base of a small, hollow and pointed seta which is always closed at its apical end. Neither sense rods not specialized cuticular parts were found within the terminal strand which always ended at the base of the seta.

The second type, also trichoid, was designated as the marginal setae, of these there are two sub-types. The first, the single marginal seta, consists of an elongated, unicunlear nerve cell; proximally there is a small nerve, distally, a terminal strand which connects the nerve cell with the base of the seta. These setae were numerous along the margin of the insect's body, each was closed at its apical end and curved slightly at its tip. The multiple marginal setae, the second sub-type, consist, in nearly every case, of three setae, one large and two smaller ones. Each of these has a single uninuclear nerve cell; that of the large seta is greater than either of the other two. There are two pairs of these multiple marginal setae, their location upon the insect's body is shown in figure one.

The third type, the marginal sense organs, are found on the dorsal surface near the margin, there are generally five or six on each side. Each consists of a nerve cell with a single nucleus, a terminal strand and a peculiar end organ. This last mentioned part contains two structures, a small colored spot surrounded by a vacuole, and a curved cuticular rod. Both of these are connected to the nerve cell by its terminal strands. The apical part of the end organ is like a circular box open at its free end, within it is a smaller duplicate piece through which passes a fine terminal hair. The basal portion of the end organ is dome-like and its roof supports and separates it from the apical part.

The fourth type, the median sense organs, form a group of about thirty. They are all nearly median in position and are situated anterior to the anal lobes. Each consists of a large nerve cell containing a single nucleus and it has a long and

thick neck extending through the cuticula and terminating in a dome-like end organ. The nerve cell has a fibrillar structure which is here much more evident than the nerve cells of the other described sensilla. The neck and the dome-like end organ are without any sense rods or other internal structures.

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ABBREVIATIONS USED IN PLATES

Ant.—antenna
Cut.—cuticula
D.—dorsal
E. O.—end organ
Hyp.—hypodermis
N.—nerve
N. C.—nerve cell
Neu. N.—neucleus of neurilemma
Oc.—ocellus
S.—seta
Tr.—trichogen
T. S.—terminal strand
X.—one of the large spaces in the dorsal cuticula.

EXPLANATION OF PLATES

Plate I

Fig. 1. Diagrammatic dorsal view of a female black scale showing the arrangement of the sense organs. The marginal setae are shown on both sides of the body. To the right they represent those of the younger specimens, on the left side the more numerous ones of an older individual. The four multiple setae, in two pairs, are represented by the larger setae. +, marginal sense organs; •, the median sense organs.

Fig. 2. A dorsal sense organ with a subhypodermal nerve cell. Only the basal part of the seta is shown.

Fig. 3. A dorsal sense organ with an intrahypodermal nerve cell. At XX are two of the large hollow spaces so abundant in the dorsal cuticula of the older black scales.

Fig. 4. Sense organ of one of the single marginal setae. One trichogen, Tr., and a portion of the regular hypodermis shown.

Fig. 5. A seta of one of the single marginal sense organs.

Fig. 6. Sense organ of one of the large setae of the multiple group. This represents the spherical type of nerve cell which here shows the large basal nucleus. Only the basal part of the seta was present. Some of the fibrils within the nerve cell are shown. The nerve cell is partially surrounded by the regular hypodermis, Hyp.

Fig. 7. A seta from one of the above mentioned sense organs.

Fig. 8. Sense organ of one of the smaller seta of the multiple marginal group. The entire smaller seta is shown and the base of one of the large ones as represented in figure seven.

Plate II

Fig. 9. Section of a marginal sense organ showing the uninuclear nerve cell, N. C., and the end organ, E. O. The basal and apical parts of the end organ are shown as well as the two structures within the former. The nerve cell shows a double terminal strand at its distal end and, proximally, the nerve. Combined from two sections.

Fig. 10. View of an end organ, more highly magnified. This shows the two contained parts, the colored spot surrounded by a vacuole and the curved cuticular rod. The terminal strand is divided to innervate both these parts.

Fig. 11. A marginal sense organ from a younger insect, probably a late second instar.

Fig. 12. Longitudinal section of a median sense organ. This shows the large nerve cell, its elongated neck and the dome-like end organ. The distal part of the nerve cell penetrates an opening in the cuticula, Cut. The fibrillar structure of the nerve cell is shown but only a portion of the fibrils have been figured.

Fig. 13. Two of the median sense cells joined together. The cells are separate but this is not shown. Above the nerve cells are two regular hypodermal cells, others are shown at either side.

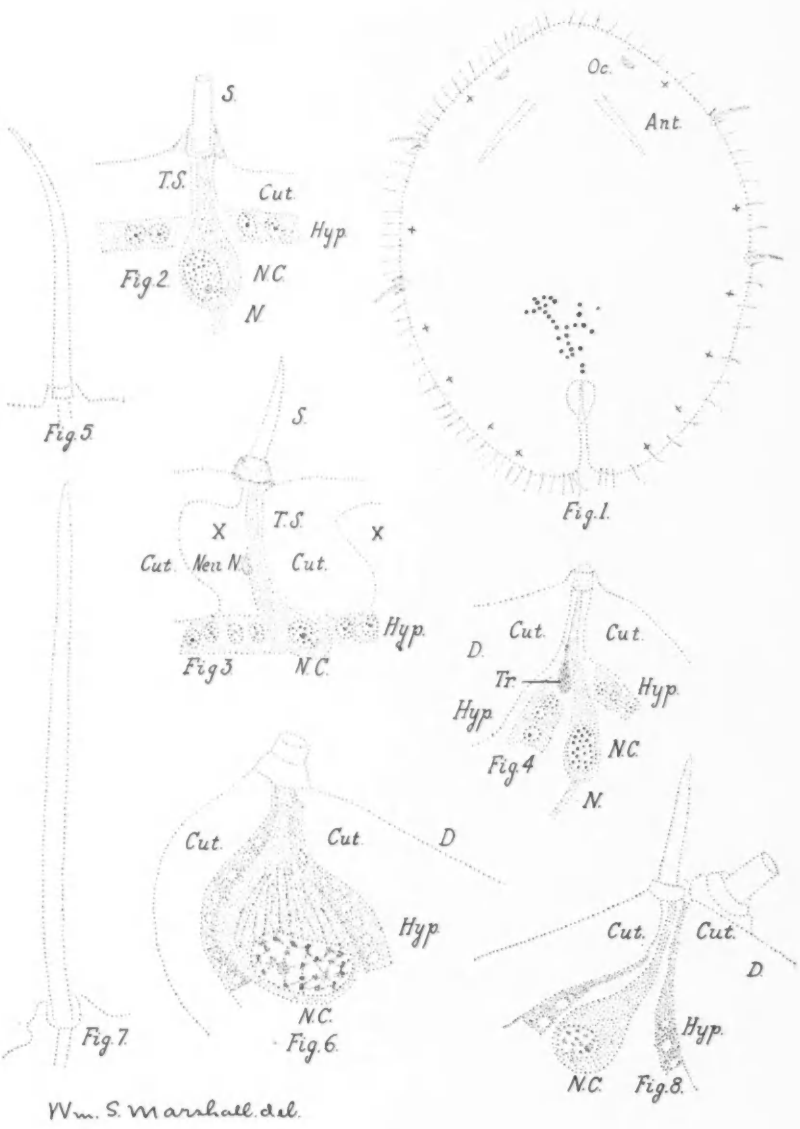
Fig. 14. Section of a median sense organ from a late second instar. This shows two tricogens, Tr.

Fig. 15. A sense cell of a median sense organ. This shows the fibrils ,only a few of them figured, in part surrounding the nucleus of the cell. The cuticular layer is to the left of the figure and from this side of the cell goes out the neck to the end organ, this was not shown in the section.

Fig. 16. A small ventral sensillum situated near the margin of the insect.

All figures are camera lucida drawings made by the following oculars and objectives, Zeiss microscope.

Fig. 1—Oc. 6, Obj. A 2.
Figs. 2, 3, 9, 11, 14, 16, Oc. 6, Obj. Im.
Figs. 4, 5, 6, 7, 8, 12, 13, 15, Oc. 6, Obj. Im.
Fig. 10, Oc. 8, Obj. Im.



Wm. S. Marshall del.

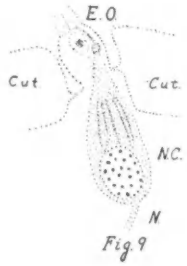


Fig. 9

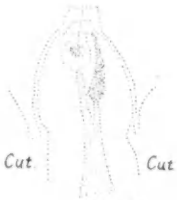


Fig. 10.

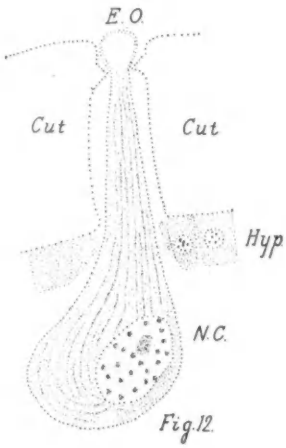


Fig. 12.

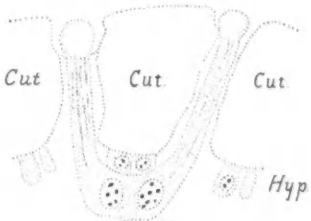


Fig. 13.

Fig. 15

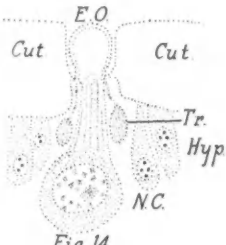


Fig. 14.

Fig. 16.

Wm. S. Marshall, del.

ON TOTAL HEMOLYMPH (BLOOD) CELL COUNTS OF INSECTS

I. Orthoptera, Odonata, Hemiptera, and Homoptera

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Members of the Class Insecta appear to be quite as variable in morphology, development, physiology, life habits and other distinguishing characteristics as are members of the Class Mammalia, but relatively few developmental and physiological variations among insects have received quantitative investigation. This is particularly true with respect to the hemolymph[2] (blood) of insects. Many comparative studies have been made upon total red and total white blood cell counts of different species of mammals, whereas measurements of total hemolymph cell counts of different species of insects rarely have been reported. In view of the fact that the hemolymph cells (amebocytes, hemocytes, leucocytes) of insects are perhaps comparable in their morphology, embryonic origin, ameboid movements, and phagocytic activities to white blood cells of mammals, a determination of total hemolymph cell counts in different insect species should be of interest from the standpoint of comparative zoology as well as entomology and insect physiology in particular.

In a previous paper on the total hemolymph cell count of the field cricket, *Gryllus assimilis pennsylvanicus* Burm., the authors (1934) noted that only a few figures on counts from insects have been reported in the literature; reference to these investigations were given. The present paper contains the results of 502 total hemolymph cell counts from 33 species of Orthoptera, Odonata, Hemiptera and Homoptera. All of these species are heterometabolous and pass through nymphal stages in their development. Counts from nymphs and adults

[1]This report is part of the research being done under a grant from the Rockefeller Fluid Research Fund, administered through Iowa State College.

[2]The term "hemolymph" is used throughout this paper to designate the circulating medium found in the heart, hemocoele and adjoining body cavities of the insect. Hemolymph is used in preference to "blood," since the latter correctly carries with it the connotation of being contained in closed vessels, a condition which is not found in the insect.

are given. Total hemolymph cell counts of holometabolous or larva-possessing species will be presented in a subsequent paper.

MATERIAL

Most of the insects used for these counts were randomly collected in the vicinity of Ames, Iowa, whenever seasonally available. As a rule, specimens were collected and utilized for hemolymph cell counts on the same day. In the case of phytophagus forms, portions of the host plant were placed, whenever possible, in the vials in which the animals were kept until the hemolymph sample was taken. Other insects, which could not be given normal food, were used as soon as possible after being brought into the laboratory.

Specimens of *Periplaneta fuliginosa*, a semitropical roach, were trapped in greenhouses on the Iowa State College campus. The single specimen of *Panchlora cubensis*, a green tropical roach, was found among some bananas which had been shipped to an Ames store. Individuals of *Blatta orientalis*, the Oriental cockroach, and *Periplaneta americana*, the American cockroach, were obtained from Kansas and Mississippi. They were kept for several weeks in large stock cages before being used for counts. During this period of acclimatization they were given water, bananas and bread. The Mormon crickets, *Anabrus simplex*, were collected in Idaho; before being used they were kept in the laboratory for over a week and fed fresh oat sprouts.

Attempts to obtain enough fluid for hemolymph cell counts were unsuccessful in the case of a number of specimens of a mole cricket, *Gryllotalpa* sp.?

METHOD

The method (including anticoagulant method, when used) of determining these insect total hemolymph cell counts was the same as that previously employed by Tauber and Yeager (1934). A double chamber hemocytometer, a special micro-diluting pipette (with which 1.22 mm.[3] of hemolymph could be diluted 150 times), and a special dilution fluid (0.081 M NaCl, 0.002 M KCl, 0.001 M $CaCl_2$, 0.005 percent gentian violet and 0.125 percent acetic acid) were used.

Samples of hemolymph were obtained, as indicated later, from either antennae, legs or both. When no anticoagulant measures were used, rapid sampling and quick dilution of hemolymph were found to be essentials for accurate counting. The individuals of *Blatta orientalis*, the Oriental cockroach, were divided into two groups: members of one group were subjected to acetic acid vapor before the hemolymph samples were taken, while the others were bled without preliminary anticoagulant treatment. Specimens of *Orchelimum vulgare*, a long-horned grasshopper, were handled similarly. These differences are indicated in Table I.

[3]The authors are indebted to several members of the Department of Zoology and Entomology (Mr. B. V. Travis, Dr. G. C. Decker, Dr. H. H. Knight, Mr. G. A. Thurber, Mr. H. Hixon, and Mr. R. L. Roudabush) for securing and identifying a number of the insects used. Mr. C. Wakeland, of the University of Idaho, supplied the Mormon crickets.

TABLE I

AVERAGE TOTAL HEMOLYMPH CELL COUNTS FROM ORTHOPTERA, ODONATA, HEMIPTERA, AND HOMOPTERA

1	2	3	4	5	6	7	8	9	10
	Species	Stage of Development	Sex of Insect	Condition of Insect	Anticoagulant	Sample from	Number Observed	Range of Counts per mm^3	Average Count per mm^3
ORTHOPTERA	*Microcentrum laurifolium* (L.) katydid	A	♂	Normal	—	Antennae, legs	1		*53,910*
	Orchelimum vulgare Har. long-horned grasshopper	A	♂	Normal	+, —	Antennae, legs	22	13,487–34,245	26,876
	" " "	A	♀	Normal	+, —	Antennae, legs	17	26,333–53,655	35,236
	" " "	A	♂, ♀	Normal	+, —	Antennae, legs	39	13,487–53,655	*30,520*
	Anabrus simplex: Mormon cricket	A, N	♂	Normal	+	Antennae	5	51,473–55,344	53,506
	" "	A, N	♀	Normal	+	Antennae	4	58,514–66,111	61,219
	" "	A, N	♂, ♀	Normal	+	Antennae	9	51,473–66,111	*56,984*
	Ceuthophilus uhleri: camel cricket	A	♀	Normal	—	Antennae	2	81,158–81,578	*81,368*
	Udeopsylla robusta: camel cricket	A	♂	Normal	—	Antennae	9	40,311–59,498	53,068
	" "	A	♀	Normal	—	Antennae	8	63,998–77,160	70,203
	" "	A	♂, ♀	Normal	—	Antennae	17	40,311–77,160	61,135
	" "	A	♂	Bacteria in hemolymph	—	Antennae	1		179,585
	" "	A	♀	Ovipositing	—	Antennae	2	104,910–166,913	135,912
	" "	N	♂, ♀	Normal	—	Antennae	3	13,740–33,075	24,935
	" "	A, N	♂, ♀	Normal	—	Antennae	20	13,740–77,160	*53,212*
	Oecanthus nigricornis Walker: tree cricket	A, N	♂, ♀	Normal	—	Antennae, legs	9	43,245–85,823	*58,353*
	" "	A	♀	Just after molt	—	Antennae, legs	1		106,493
	Nemobius sp.? small field cricket	A	♂	Normal	—	Antennae	4	36,743–48,075	41,743
	" " "	A	♀	Normal	—	Antennae	3	63,158–63,413	63,270
	" " "	A	♀	Ovipositing	—	Antennae	3	72,825–76,336	74,020
	" " "	A	♂, ♀	Normal	—	Antennae	7	36,743–63,413	*50,969*
	Melanoplus femur-rubrum DeG.: red-legged grasshopper	A	♂, ♀	Normal	—	Antennae	6	13,278–16,889	*15,023*
	" " "	A	♂, ♀	Parasitized by *Gordius* Larvae	—	Antennae	6	27,743–36,165	31,994

TABLE I—(Continued)

1	2	3	4	5	6	7	8	9	10
	Species	Stage of Development	Sex of Insect	Condition of Insect	Anticoagulant	Sample from	Number Observed	Range of Counts per mm³	Average Count per mm³
ORTHOPTERA	*M. spretus* Uhl.: grasshopper	A	♂, ♀	Normal	—	Antennae	14	18,881–32,498	*24,534*
	M. differentialis Thos.: differential grasshopper	A	♂, ♀	Normal	—	Antennae	11	19,547–27,440	23,509
	" "	N	♂, ♀	Normal	—	Antennae	2	15,860–17,240	16,550
	" "	A, N	♂, ♀	Normal	—	Antennae	13	15,860–27,440	*22,438*
	M. bivittatus Say: two-striped grasshopper	A	♂, ♀	Normal	—	Antennae	3	32,573–41,828	*38,243*
	Melanoplus sp.?	N	♂, ♀	Normal	—	Antennae	4	7,748–13,665	*10,810*
	Dissosteira carolina L.: Carolina or roadside grasshopper	A	♂	Normal	—	Antennae	2	35,910–36,158	36,034
	" " "	A	♀	Normal	—	Antennae	4	53,408–61,320	56,033
	" " "	A	♂, ♀	Normal	—	Antennae	6	35,910–61,320	*49,367*
	Arphia sulphurea Fab.: grasshopper	A	♂	Normal	—	Antennae	4	14,663–18,075	16,348
	"	A	♀	Normal	—	Antennae	1	.....	22,588
	"	A	♂, ♀	Normal	—	Antennae	5	14,663–22,588	*17,596*
	Blattella germanica L.: German cockroach	A	♂, ♀	Normal	+	Antennae, legs	12	17,651–23,910	*20 676*
	Blatta orientalis L.: Oriental cockroach	A, N	♂, ♀	Normal	+, —	Antennae	125	15,588–57,600	*32,858*
	" "	A	♂, ♀	Bacteria in hemolymph	+, —	Antennae	5	55,360–76,500	69,280
	" "	N	♂	Just after molt	+	Antennae	1	.....	44.745
	" "	A	♀	Carrying ootheca	+	Antennae	2	51,078–60,240	55,659
	Periplaneta americana L.: American cockroach	A, N	♂, ♀	Normal	—	Antennae	9	47,833–55,665	*51,035*
	" "	A	♀	Carrying ootheca	—	Antennae	1	.....	83,580
	P. fuliginosa Serville: semi-tropical cockroach	A, N	♂, ♀	Normal	—	Antennae	66	10,074–70,110	*27,000*
	" "	N	♂	Few hours after molt	—	Antennae	1	.....	41,995
	" "	A	♀	Carrying ootheca	—	Antennae	1	.....	70,328
	Parcoblatta pennsylvanica DeG.: wood cockroach	A, N	♂, ♀	Normal	—	Antennae	5	17,910–20,325	*20,221*
	" "	A	♀	Carrying ootheca	—	Antennae	2	29,078–30,240	29,659
	Panchlora cubensis Saus.: tropical cockroach	A	♀	Carrying ootheca	—	Antennae	1	.....	*44,639*

TABLE I—(Continued)

1	2	3	4	5	6	7	8	9	10
	Species	Stage of Development	Sex of Insect	Condition of Insect	Anticoagulant	Sample from	Number Observed	Range of Counts per mm^3	Average Count per mm^3
Odonata	*Plathemis lydia* (Drury): dragonfly	A	♂	Normal	—	Legs	1		41,828
	"	N	?	Normal	—	Legs	1		15,825
	"	A, N	♂, ?	Normal	—	Legs	2	15,825–41,828	*28,827*
	Lestes unguiculatus Hagen: damsel fly	A	♂, ♀	Normal	+	Legs	6	10,500–11,325	*10,836*
Hemiptera	*Belastoma fluminea* Say: diving beetle	A	♂	Normal	+	Legs	2	13,220–14,330	*13,775*
	Gerris marginatus Say: water-strider	A	♂	Normal	—	Legs	2	10,830–12,000	*11,415*
	Reduviidae: assassin bug	N	♂, ♀	Normal	—	Legs	5	50,243–57,998	*53,028*
	Anasa tristis DeG.: squash bug	A, N	♂, ♀	Normal	+ —	Antennae, legs	16	228– 4,913	*1,637*
	Leptocoris trivittatus (Say): boxelder bug	A	♂, ♀	Normal	—	Antennae, legs	19	4,823–11,663	*7,179*
	Nezara viridula (L.): stink bug	A	♂, ♀	Normal	—	Legs	4	19,328–21,330	*20,226*
	Acrosternum hilaris (Say): stink bug	A	♂, ♀	Normal	—	Legs	4	18,083–18,750	*18,518*
	Peribalus limbolarius Stal: stink bug	A, N	♂, ♀	Normal	—	Legs	8	8,250–11,828	*9,620*
	Euschistus sp.? stink bug	A	♂, ♀	Normal	—	Legs	3	12,075–14,490	13,105
	" "	N	♂, ♀	Normal	—	Legs	4	13,575–15,990	15,242
	" "	A, N	♂, ♀	Normal	—	Legs	7	12,075–15,990	*14,326*
Homoptera	*Ceresa bubalus* (Fab.): buffalo treehopper	A	♂, ♀	Normal	+	Legs	21	46,070–64,900	*55,911*
	Glossonotus turriculatus Emm.: treehopper	A	♂, ♀	Normal	+	Legs	24	38,160–48,740	*41,734*

RESULTS

The results of the 502 total hemolymph cell counts from the 33 species of Orthoptera, Odonata, Hemiptera and Homoptera are given in condensed form in Table I. The different species are separated into four orders in column 1. Both the scientific and common names of each form are usually given (column 2). Developmental stages are designated (column 3) by N (nymph) and A (adult); if counts from both stages were made, both are indicated. Wherever possible, the sex is indicated (column 4). As utilized in column 5, the term "normal" signifies that, as far as the authors could discern, the animals so indicated were in no special physiological or pathological state when the hemolymph sample was taken; when any unusual condition such as parasitism, ecdysis, oviposition, etc., was observed, the distinction is noted. Use or non-use of anticoagulant measures is marked (column 6) for each group by the signs "+" and "—," respectively; if part of one species was subjected to the acid vapor, and the remainder of the same species was utilized without the anticoagulant, both signs are used, as: "+," "—." Variations in site of and method of obtaining hemolymph samples are indicated in column 7. The number of insects used is given in column 8. The highest and lowest counts from each group are given (column 9) to indicate, so far as this study is concerned, the range of counts from that particular group. An average count is placed in column 10 for each sex and stage of species, whenever these figures are available; also an average value (in italics) is given for all normal individuals of the same species, taken as one group.

DISCUSSION

The information recorded in Table I presents several interesting features. In order to ensure clarity, certain data from Table I are rearranged into the tables given below.

1. *Range of total hemolymph cell counts:* The insect total hemolymph cell counts given here vary throughout a range that is quite comparable to the range of variation of total white blood cell counts obtained by other investigators from mammals. Examination of Table I shows, for example, that the counts of those species in which ten or more individuals have been used range from 13,487 to 53,655 cells per mm.^{3} hemolymph in *Orchelimum vulgare* (1:3.9); from 13,740 to 77,160 in *Udeopsylla robusta* (1:5.6); from 18,881 to 32,498 in *Melanoplus spretus* (1:1.7); from 15,860 to 27,440 in *M. differentialis* (1:1.7); from 17,651 to 23,910 in *Blattella germanica* (1:1.3); from 15,588 to 57,600 in *Blatta orientalis* (1:3.7); from 10,074 to 70,110 in *Periplaneta fuliginosa* (1:6.9); from 4,823 to 11,663 in *Leptocoris trivittatus* (1:2.4); from 46,070 to 64,900 in *Ceresa bubalus* (1:1.4); and from 38,160 to 48,740 in *Glossonatus turriculatus* (1:1.2). The authors have shown previously that in *Gryllus assimilis pennsylvanicus* the normal range is from 15,700 to 159,158 (1:10) cells per mm.^{3} hemolymph. The figures in parentheses represent the ratio of lowest to highest count. Scarborough (1930, 1931) has collected data from the literature on the blood pictures of common laboratory animals and shows that the normal total white

blood cell counts range from 3,000 to 19,800 cells per mm.^{3} blood in the *rabbit* (1:6.6); from 4,200 to 24,200 in the *guinea pig* (1:5.8); from 6,500 to 26,000 in the *rat* (1:4.0); from 6,000 to 39,400 in the *cat* (1:6.6); from 3,000 to 40,500 in the *dog* (1:13.5); from 7,500 to 25,000 in the *pig* (1:3.3); and from 8,300 to 31,600 in the monkey (1:3.8). Hewitt (1932) reports that the *pig* count varies from 6,400 to 50,400 (1:7.9). The ratios, given in parentheses, are not given by Scarborough or Hewitt. From a comparison of these insect counts with these and other mammalian counts found in the literature, it would seem, in general, that the insect and mammalian total leucocyte counts tend to vary over equally large ranges, but that the *average* imaginal insect counts tend definitely to have greater values than the *average* mammalian white cell counts. The surprising probability is not that the insect, with its presumed less rigid control over internal environment, should exhibit a variable hemolymph cell count, but that the mammal, with its presumed more rigid control over its internal environment, should exhibit an almost equally wide variation in total white cell count.

TABLE II

AVERAGE TOTAL HEMOLYMPH CELL COUNTS FROM MALE AND FEMALE INSECTS OF SAME SPECIES

Species	Average Count from ♂	Average Count from ♀	♂, ♀ Ratio
Orchelimum vulgare: long-horned grasshopper	26,876	35,236	0.762
Anabrus simplex: Mormon cricket	53,596	61,219	0.875
Udeopsylla robusta: camel cricket	53,068	70,203	0.755
Nemobius sp.? small field cricket	41,743	63,270	0.660
Dissosteira carolina: Carolina grasshopper	36,034	56,033	0.643
Arphia sulphurea: grasshopper	16,348	22,588	0.724

2. *Comparison of counts from male and female insects of the same species:* In Table II are found average total hemolymph cell counts from male and female individuals of the six different species in which the sexes could be easily separated. In every case the average count from the females is higher than that from the males. In the last column of the table are given ratios of male to female average counts. These range from that of *A. simplex*, in which the male count is 87.5 percent of the female count, to that of *D. carolina*, in which the male count is 64.3 percent of the female count.

A similar sex difference was reported previously by the authors (1934) for the field cricket, *Gryllus assimilis pennsylvanicus*, in which the average total hemolymph cell count from males was found to be 87.6 percent of that from females.

Whether this difference is an inherent sex characteristic or is due to special conditions that sometimes may exist in the female has not been determined, but there is evidence, presented later, that some

high total hemolymph cell counts in female insects may be associated with periods of oviposition. It is not improbable that high counts may also occur during the period of egg formation preceding egg deposition. Without special examination, the process of egg formation inside the body of the female is not easily detected; specimens in this condition might be classified as "normal," and hemolymph cell counts from them would tend to make the average count higher than that from normal males.

3. *Differences between nymphs and adults:* In the Orthoptera, imagos of *U. robusta*, *M. differentialis* and *M. femur-rubrum* have average total hemolymph cell counts that are higher than the average counts from nymphs of the same species. Values for the counts are given in Table III, the last column of which gives the ratios of nymphal to imaginal average counts. Thus, in *U. robusta*, the average nymphal count is only 40.7 percent of the average imaginal count. Only one species is available in the Odonata (*P. lydia*), in which the nymphal

TABLE III

AVERAGE TOTAL HEMOLYMPH CELL COUNTS FROM MATURE AND IMMATURE INSECTS OF SAME SPECIES IN ORTHOPTERA, ODONATA, AND HEMIPTERA

Species	Average Count Imagos	Average Count Nymphs	Nymph, Imago Ratio
Udeopsylla robusta: camel cricket	61,135	24,935	0.407
Melanoplus differentialis: grasshopper	23,509	16,550	0.704
M. femur-rubrum: red-legged grasshopper	15,023	10,810	0.719
Plathemis lydia: dragonfly	41,828	15,825	0.378
Euschistus sp.? stink bug	13,105	15,242	1.163

count is 37.8 percent of the imaginal count, and additional counts will need to be made before it can be determined whether the same nymph-imago count difference exists in the Odonata as in the Orthoptera. Among the Hemiptera, the nymphal count of *Euschistus* sp.? is very slightly higher than the imaginal; this is the only case, of the heterometabolus forms so far studied, in which the nymph adult ratio has been found to exceed unity.

The authors (1934) have also found that the average total hemolymph cell count from nymphs of the field cricket is approximately 61 percent of that from the adults of the same species. Whether there is a gradual increase in the value of the count as the nymph approaches the adult stage has not yet been determined, but there is a possibility that such a gradation may occur. Such a change has already been suggested on speculative grounds by Tillyard (1917) with reference to the dragonflies.

4. *High total hemolymph cell counts associated with special conditions in the insect:* The authors have already suggested elsewhere (1934) that certain physiological and pathological states such as parasitism (bacterial or thread worms), oviposition and ecdysis may be

associated with or possibly be the cause of unusually high total hemolymph cell counts in the affected insect. Further evidence in support of this suggestion is supplied by the present study. Values for the range of normal counts in a given species and figures for the count from affected individuals of the same species are given in the following table. In nearly every case the count of the affected individual lies above the range of recognized "normal" counts.

TABLE IV

COMPARISON OF TOTAL HEMOLYMPH CELL COUNTS FROM NORMAL INSECTS, AND COUNTS FROM INSECTS IN CERTAIN PHYSIOLOGICAL AND PATHOLOGICAL CONDITIONS

Species	Range Normal Count x 10^3 (Approximately)	Single Count from Affected Individual	Condition
Udeopsylla robusta:			
camel cricket	40–60 (A, ♂)	179,585 (A, ♂)	Bacteria in hemolymph
" "	64–77 (A, ♀)	166,913 (A, ♀)	Ovipositing
" "	64–77 (A, ♀)	104,910 (A, ♀)	Ovipositing
Oecanthus nigricornis:			
tree cricket	43–86 (A, N, ♂, ♀)	106,493 (A, ♀)	Just after last molt
Nemobius sp.?			
small field cricket	63.2–63.4 (A, ♀)	76,336 (A, ♀)	Ovipositing
" " "	63.2–63.4 (A, ♀)	72,900 (A, ♀)	Ovipositing
" " "	63.2–63.4 (A, ♀)	72,336 (A, ♀)	Ovipositing
Melanoplus femur-rubrum:			
grasshopper	13–17 (A, ♂, ♀)	36,165 (A, ♀)	Parasitized by *Gordius* larvae
"	13–17 (A, ♂, ♀)	34,410 (A, ♀)	" " "
"	13–17 (A, ♂, ♀)	31,995 (A, ♂)	" " "
"	13–17 (A, ♂, ♀)	31,740 (A, ♀)	" " "
"	13–17 (A, ♂, ♀)	29,910 (A, ♂)	" " "
"	13–17 (A, ♂, ♀)	27,743 (A, ♂)	" " "
Blatta orientalis:			
Oriental cockroach	16–58 (A, N, ♂, ♀)	76,500 (A, ♂)	Bacteria in hemolymph
" "	16–58 (A, N, ♂, ♀)	75,578 (A, ♂)	" "
" "	16–58 (A, N, ♂, ♀)	75,300 (N, ♂)	" "
" "	16–58 (A, N, ♂, ♀)	63,660 (N, ♀)	" "
" "	16–58 (A, N, ♂, ♀)	55,360 (A, ♀)	" "
" "	16–58 (A, N, ♂, ♀)	44,745 (N, ♂)	Just after molt
" "	16–58 (A, N, ♂, ♀)	60,240 (A, ♀)	Carrying ootheca
" "	16–58 (A, N, ♂, ♀)	51,078 (A, ♀)	Carrying ootheca
Periplaneta americana:			
American cockroach	48–56 (A, N, ♂, ♀)	83,580 (A, ♀)	Carrying ootheca
P. fuliginosa:			
semi-tropical cockroach	10–70 (A, N, ♂, ♀)	41,995 (N, ♂)	Few hours after molt
" "	10–70 (A, N, ♂, ♀)	70,328 (A, ♀)	Carrying ootheca
Parcoblatta pennsylvanica:			
wood cockroach	18–20 (A, N, ♂, ♀)	29,659 (A, ♀)	Carrying ootheca

Just how these various conditions are causally related to the associated high counts is not clear. It is obvious, however, that an increase in total count may result from either a dehydration of the hemolymph or an increased rate of formation of hemolymph cells, or from both.

5. *Use of anticoagulant:* One important source of error in the determination of total hemolymph cell counts of insects is the tendency of certain cells to agglutinate into cell coagula (see Yeager, Shull and Farrar, 1932; and Yeager and Tauber, 1932). Cell coagulation may

be initiated within only a few seconds after the beginning of sampling unless proper precautions are taken. This source of error may be eliminated either by the use of very small hemolymph samples in conjunction with a rapid technique that permits dilution of the sample in the micro-pipette before the initiation of coagulation, or by the use of an anticoagulant such as glacial acetic acid vapor or heat (60° C. for 10 minutes). Both the micropipette-rapid dilution method and the acetic acid vapor anticoagulant method were used in the cases of two of the species included in this report. In the case of each species, about half of the individuals were treated with acetic acid vapor before taking a sample of hemolymph for the count, while hemolymph samples of the remaining untreated individuals were obtained by means of the rapid dilution technique. Thus, specimens of *Orchelimum vulgare* treated with acetic acid had an average count of 31,770 while those untreated had an average count of 28,902 cells per mm.^{3} of hemolymph. In the case of *Blatta orientalis*, the average counts were 32,759 and 32,973 cells per mm.^{3} hemolymph of the treated and untreated animals, respectively. In each species the difference between these average counts is not significantly great. This indicates that, with untreated animals, the rapid dilution method can be relied upon to give results comparable to those obtained by the use of a larger sample of hemolymph taken from insects treated with acetic acid vapor as an anticoagulant.

6. *Comparison of results with previously published values of total hemolymph cell counts in insects:* Yeager and Tauber (1932) report an average value of 30,572 cells per mm.^{3} hemolymph from 18 individuals of *Periplaneta fuliginosa*, while the present study shows an average of 27,000 cells per mm.^{3} hemolymph from 66 individuals of the same species. Yeager and Tauber (1933) also report an average of 31,673 cells per mm.^{3} hemolymph from 14 individuals of *Blatta orientalis;* Fisher (1934) gives two values for average total counts of this species: 34,635 and 32,903 cells per mm.^{3} hemolymph for groups of 25 and 34 animals, respectively. The present study shows an average of 32,698 cells per mm.^{3} hemolymph from a group of 125 individuals of *B. orientalis*. These figures indicate that, in spite of the wide range of counts and the several factors that may cause variation, average total hemolymph cell counts of insects may be satisfactorily duplicated.

SUMMARY AND CONCLUSIONS

1. Total hemolymph cell counts from 502 individuals of 33 different species of insects belonging to the orders Orthoptera, Odonata, Hemiptera and Homoptera have been determined. Various average counts and the limits of the corresponding ranges of variation of individual counts have been reported.

2. Insofar as this study indicates, the average count from female insects of these orders is higher than the average count from male insects of the same species. The average male

count has been found to vary from 87.5 to 64.3 percent of the value of the average female count of the same species. This confirms the authors' previous findings based on 220 counts of the field cricket, in which the average count from males was found to be 87.6 percent that of the females. It is suggested that this sex difference may be associated with the process of egg formation and deposition.

3. Insofar as this study indicates, the average counts of Orthopteran imagos are higher than the average counts from the nymphs of the same species, the average nymphal counts ranging from 71.9 to 40.7 percent of the corresponding imaginal counts. This is in agreement with the authors' previous findings in the case of the field cricket, in which the average nymphal count was found to be approximately 61 per cent of the average imaginal count. Whether similar developmental differences may be found also in the Odonata, Hemiptera and Homoptera is not adequately indicated by the meager data at hand.

4. Further evidence is presented in support of the authors' previously made suggestion that certain physiological or pathological conditions, such as parasitism, ecdysis and oviposition, tend to be associated, perhaps causally, with high total hemolymph cell counts in the insect.

5. Comparative average counts are given to show that the total hemolymph cell counts determined by the micropipette rapid dilution method, without the use of anticoagulant measures, are not significantly different from counts made from insects treated with glacial acetic acid vapor in order to prevent cell coagulation.

6. Values for average counts of *Periplaneta fuliginosa* and *Blatta orientalis* included in this study agree with previously published average counts of these two species, indicating that average total hemolymph cell counts of the insect can be satisfactorily duplicated.

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THE CADDIS FLIES OR TRICHOPTERA OF NEW YORK STATE, by CORNELIUS BETTEN with chapters by B. L. KJELLGREN, A. W. ORCUTT and M. B. DAVIS; pp. 1–576, 61 text figures and 67 plates. Bull. N. Y. State Mus., No. 292, Dec., 1934. Albany, N. Y. Price, $3.00.

This much needed volume has finally appeared. The reviewer saw the "revised" manuscript at Cornell in 1915. It had been practically completed nine years before. Projects of more immediate use to the tax-payer used the Museum funds that had been planned for its publication. One new species after another was scooped by various casual students of the order. The last scoop was accomplished by one who had had the privilege of studying the manuscript and who rushed two papers through by publishing privately after the present volume was on the press. Further as a reward for the author's remarkable abilities and genial disposition he has been commandeered into executive work by one of our leading scientific schools. Such are the rewards of science by the non-scientific awarding powers that be. While our modern society is founded on science it is administered by the passing executive. With a rising threat from T. H. Frison to use the caddis flies of the eastern states, manuscript and all, for his Natural History Survey of Illinois, the original volume, repeatedly revised by the author, finally has been published.

For the first time in the history of work on the Trichoptera of North America we have a well organized key to the group. With 1,010 illustrations it will be the "Bible" of trichopterists for many years to come. Pages 5–115 are devoted to the anatomy of larvae and adults and to habits and distribution. Pages 116–418 are taxonomic. "There are here included generic descriptions, with keys, of all North American genera, and specific descriptions of all North American species east of the Mississippi and north of Mexico" (p. 5). A total of 568 species are described. Pages 419–473 are devoted to what appears to be a bibliography of the world literature on this order.

It might be well to warn beginners that this work does not offer solutions to all problems on this group of insects. The adult caddis fly is a degenerate insect with poor characters for the higher groups. Students of the reviewer have found specimens that had the characters of one family in the left wings and of another family in the right wing. Eventually the taxonomy of the group will be cleared up by extensive study of the larvae where characters are probably more generic.

Doctor Betten has given us one of the great works in entomology of this decade. The Director of the Museum is to be congratulated in accomplishing what his predecessors failed to do and also on the quality of the press work and paper.—C. H. K.

ON THE GENUS ONCOPHANES FOERSTER, WITH DESCRIPTIONS OF TWO NEW RELATED GENERA

(Hymenoptera: Braconidae)

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Among material from various sources recently received for identification have been four apparently undescribed species of Rogadinae, two of which could be referred definitely to *Epirhyssalus* Ashmead while the others, although obiviously related to that genus, exhibited differences which seemed to exclude them. In an attempt to place these a study of *Epirhyssalus* and its nearest relatives was undertaken. This has resulted in the conclusion that *Epirhyssalus* is clearly identical with *Oncophanes* Foerster and must fall as a synonym of that name, and that a new generic name must be proposed for each of two of the four species mentioned above.

Oncophanes Foerster

Oncophanes Foerster. Verh. naturh. Ver. preuss. Rheinl., 19: 241, 1862. Genotype, *Exothecus minutus* Wesm.
Epirhyssalus Ashmead. Proc. U. S. Nat. Mus., 23: 142, 1900. Genotype, *Epirhyssalus californicus* Ashmead. New synonymy.

Some years ago I had the privilege of studying Wesmael's type of *Exothecus minutus* which is in the collection of the Academy of Science at Brussells. A comparison of my notes on that species with the type of *Epirhyssalus californicus* shows conclusively that the two genotypes are congeneric. They are, in fact, very similar and would fall close together in an arrangement of the world species of this genus.

Oncophanes appears to be most closely related to *Clinocentrus* Hal., which it especially resembles in the large, connate, heavily sclerotized, and laterally acutely margined second and third tergites, with the following tergites more weakly sclerotized and usually more or less retracted. It may be distinguished from that genus by its usually less elongate form, by its interstitial or nearly interstitial recurrent vein, by its relatively longer first segment of the antennal flagellum, which is as long as the scape and pedicel combined, by its somewhat smaller eyes and usually more convex temples, and, finally, what

appears to be of most significance, by the position of the spiracles of the second and third abdominal segments below the acute lateral margins of the tergites. There seems to be also a biological difference between the two genera. In so far as I have been able to determine, the cocoon in *Clinocentrus* is always formed within the host larval skin, just as in species of *Rogas*, while in the case of *Oncophanes* the full-grown larvae emerge from the host to form their cocoons.

The following key will separate *Clinocentrus*, *Oncophanes*, and the two new genera described in this paper:

1. Prepectus immargined; notauli incomplete (page 246)..... **Xenosternum**
   Prepectus sharply margined; notauli complete..... 2
2. Suturiform articulation complete, strongly impressed; apical margin of third tergite narrowly depressed, denticulate toward sides (page 248), **Aulosaphes**
   Suturiform articulation not complete, only weakly marked laterally; apical margin of third tergite not depressed and not denticulate..... 3
3. Spiracles of second and third abdominal segments situated on the dorsum, above the acute lateral margins of the tergites; recurrent vein strongly antefurcal; first segment of antennal flagellum not as long as scape and pedicel combined (page 246)..... **Clinocentrus**
   Spiracles of second and third abdominal segments situated on the sides, below the acute lateral margins of the tergites; recurrent vein interstitial or nearly so; first segment of antennal flagellum as long as scape and pedicel combined (page 241)..... **Oncophanes**

KEY TO THE NEARCTIC SPECIES OF ONCOPHANES FOERSTER

1. Thorax, including mesopleura and mesosternum, black or blackish..... 2
   Thorax yellowish ferruginous, sometimes more or less piceous on the dorsum; mesopleura and mesosternum always pale (page 242)..... **atriceps**
2. Basal three tergites entirely black and completely closely sculptured and opaque; nervulus postfurcal by less than its length (page 243)..**nigriventris**
   Connate second and third tergites more or less yellowish-brown, broadly smooth laterally, shining, the third very weakly sculptured; nervulus postfurcal by more than its length..... 3
3. Third abdominal tergite with a transverse row of rather large, shallow punctures before apex, broadly smooth along apical margin; first abscissa of radius more than half as long as second; postnervellus originating at junction of cubitella and basella; fourth and following tergites lighter in color than second and third (page 244)..... **californicus**
   Third abdominal tergite not as above; first abscissa of radius less than half as long as second; postnervellus originating basad of junction of cubitella and basella; fourth and following tergites darker than second and third (page 245)..... **betulae**

Oncophanes atriceps (Ashmead), new combination

Rhyssalus atriceps Ashmead, Proc. U. S. Nat. Mus., 11: 628, 1889 (1888).
Rhyssalus similis Ashmead, Proc. U. S. Nat. Mus., 11: 628, 1889 (1888). New synonymy.
Rhyssalus loxoteniae Ashmead, Proc. U. S. Nat. Mus., 11: 628, 1889 (1888). New synonymy.
Clinocentrus americanus Weed, Bul. Ill. Lab. Nat. Hist., 3: 43, 1890. New synonymy.
Epirhyssalus atriceps Viereck, Proc. U. S. Nat. Mus., 44: 559, 1913.
Epirhyssalus similis Viereck, Proc. U. S. Nat. Mus., 44: 559, 1913.
Epirhyssalus loxoteniae Viereck, Proc. U. S. Nat. Mus., 44: 559, 1913.

The National Collection contains the type series of the three species described by Ashmead and a cotype of Weed's *americanus*. After studying these and a considerable number of other series of specimens, most of which had been identified as *Epirhyssalus atriceps*, it is my opinion that the four names apply to a single species; *atriceps* has line precedence over *similis* and *loxoteniae* and is the valid name.

In structure and sculpture this species appears to be more similar to *nigriventris* than to either of the two remaining North American species, but the color, as shown in the key, will at once distinguish it.

It is decidedly the most common of our species, on the basis of the collection of the United States National Museum, which contains more than 200 specimens from Connecticut, Pennsylvania, Delaware, the District of Columbia, Virginia, Ohio, Michigan, Indiana, Illinois, Missouri, Kansas, Iowa, and Quebec, Canada. In the records accompanying these specimens the following Lepidoptera are mentioned as hosts: *Amorbia humerosana* Clemens, *Ancylis comptana* Froelich, *Archips cerasivorana* Fitch, *A. clemensiana* Fernald, *A. rosaceana* Harris, *Argyrotaenia velutinana* Walker, *Gelechia confusella* Chambers, *G. trialbamaculella* Chambers, *Gracilaria* species, *Hedia cyanana* Murtfeldt, *Sparganothis flavibasana* Fernald, *S. idaeusalis* Walker, and *S. sulfureana* Clemens.

Oncophanes nigriventris, new species

This species may be distinguished from the other known North American species by the completely black and closely sculptured basal three tergites.

Female.—Length, 2 mm. Head in dorsal view more than twice as broad as long, entirely smooth and polished; face definitely broader than long to anterior margin of clypeus; malar space slightly longer than basal width of mandible; temples and cheeks rounded, narrower than eyes; ocelli in an equilateral triangle; ocellocular line distinctly more than twice the diameter of an ocellus; antennae about as long as the body, 24-segmented; flagellum not tapering to apex, first segment distinctly longer than the second, those beyond second decreasing almost imperceptibly in length; maxillary palpi slightly longer than width of head.

Thorax at tegulae about as broad as head, about as wide as high; mesoscutum smooth and shining except for numerous minute setiferous papillae on anterior declivity of middle lobe; notauli fine but distinct and complete, meeting at apex of mesoscutum; impression at base of scutellum barely more than twice as broad as long with several weak

longitudinal ridges; propodeum with a very short median longitudinal carina followed by a sharply limited pentagonal areola of which the sides forming the strongly acute anterior angle are much longer than the others; petiolar area about as large as areola, narrowing cephalad; base of propodeum smooth, remainder rugulose reticulate; mesopleurum polished, with a strongly foveate longitudinal furrow below; radius originating from middle of stigma, its first abscissa half the length of the second and more than half as long as the first intercubitus; recurrent vein shorter than first intercubitus and entering second cubital cell at extreme base; nervulus postfurcal by less than its length; postnervellus weak, originating at the angle formed by the two abscissae of basella.

Abdomen as broad as thorax; first tergite large, at least as broad at apex as long, completely closely longitudinally striate and minutely punctate within the striae; connate second and third tergites nearly parallel-sided, the second sculptured like the first, the third closely finely rugulose with only a weak suggestion of striation; following tergites almost completely retracted; ovipositor sheath a little longer than posterior femur.

Black; scape and pedicel brownish yellow; palpi yellowish white; wings hyaline; stigma and veins pale fuscohyaline; legs yellow; abdomen black except the weakly sclerotized, mostly retracted, apical segments, which are brownish yellow.

Type locality.—Mt. Pleasant, Iowa.

Type.—U. S. N. M. No. 50598.

Described from four female specimens. The type was collected May 23, 1931, and submitted for identification by H. E. Jaques, of Iowa Wesleyan College. One paratype was collected at Michigan Agricultural College, May 12, 1891, by C. F. Baker. The two remaining paratypes are from Cabin John, Maryland, one collected September 7, 1903, by T. Pergande, the other taken June 3, 1917, by R. M. Fouts. In two of the paratypes the recurrent vein is continuous with the first intercubitus.

Oncophanes californicus (Ashmead), new combination

Epirhyssalus californicas Ashmead [sic], Proc. U. S. Nat. Mus., 23: 142, 1900.

This species was described only through the characterization of the genus *Epirhyssalus* in Ashmead's key to the genera of Rhyssalini and was based on a single female specimen from Santa Cruz Mountains, California. It rather closely resembles *betulae* and agrees with my description of that species except as follows:

Length, 2 mm.; malar space not distinctly longer than basal width of mandible; antennae broken; impression at base of scutellum not distinctly half as long as scutellum; median area of propodeum more or

less pentagonal, the anterior angle acute; first abscissa of radius more than half as long as second; postnervellus originating at junction of cubitella with basella, basella thus made up of only two abscissae; second tergite longitudinally striate except at the sides, the striae straight and not punctate; third tergite broadly smooth across apex, with a transverse row of large, shallow punctures at base of this smooth band. Antennae yellowish brown; a large median brown area on posterior half of mesoscutum; pronotum ferruginous; tarsi, except apical segment, entirely bright yellow; second and third tergites piceous, brownish toward the sides, the third also brownish along posterior margin; following tergites yellowish brown.

Known only from the holotype.

Oncophanes betulae, new species

Most similar to *californicus* (Ashmead) but distinguished as shown in the foregoing key. In addition, the thorax is more intensely black, the connate second and third tergites are paler, and the following tergites are darker than in the type and only known specimen of *californicus*.

Female.—Length, 2.5 mm. Head as seen from above more than twice as broad as long, entirely smooth and polished; face much broader than long; malar space longer than basal width of mandible; temples rather strongly convex but narrower than eyes; postocellar line much shorter than ocellocular line, the latter more than twice as long as diameter of an ocellus; left antenna of type 22-segmented, right 23-segmented, hardly as long as the body, all flagellar segments elongate but becoming successively slightly shorter toward apex, the first as long as scape and pedicel combined.

Thorax at least as broad as high; mesoscutum smooth and shining; notauli distinctly impressed but narrow and not broadening anteriorly; impression at base of scutellum half as long as scutellum, divided by a low median longitudinal ridge; scutellum weakly convex, polished; propodeum with a very short basal median carina followed by a completely enclosed small pyriform areola which is broadest behind and extends beyond middle of propodeum; behind areola a small, narrow, subtriangular petiolar area which is narrowest at its junction with the areola; remainder of propodeum more or less coarsely reticulate; a large area each side of middle at base smooth; mesopleurum smooth and polished, with a rather broad longitudinal foveolate furrow below and a small rugulose area beneath tegula; metapleurum finely rugulose; stigma more than twice as long as broad, emitting the radius from its middle; first abscissa of radius less than half as long as second and not more than half the first intercubitus; recurrent vein interstitial with first intercubitus, nervulus postfurcal by more than its own length; radiella represented by a weak short spur; postnervellus definitely basad of junction of basella and cubitella, the basella thus consisting of three abscissae.

Abdomen narrow at base, broader at apex of third tergite than thorax; first tergite longer than broad at apex, longitudinally rugulosostriate; position of suturiform articulation weakly indicated laterally; second tergite, except at the sides where it is smooth, longitudinally finely striate, the striae irregular and finely punctate; third tergite mostly smooth, with only a little poorly defined transverse roughening medially; following tergites combined only a little more than half as long as fused second and third, strongly narrowed to apex, smooth and shining; ovipositor sheath about as long as posterior femur.

Black; scape and pedicel more or less brownish; palpi and mandibles except at tips, yellowish; wings hyaline, stigma and veins pale brown; legs entirely yellow except all tarsi, which are weakly infuscated; fused second and third tergites brownish yellow, indefinitely piceous toward base; fourth and following tergites blackish.

Type locality.—Mt. Desert Island, Maine.

Type.—U. S. N. M. No. 50599.

Host.—(?) *Phyllotoma nemorata* Fallen, a leaf-mining sawfly infesting birch.

Four female specimens, the type and one paratype reared June 8, 1933, and two paratypes reared June 6, 1933, by A. E. Brower. The host record, if correct, represents a departure in this species from the usual host association in *Oncophanes*, the recorded hosts of other species being lepidopterous leaf-rollers and leaf-folders.

Clinocentrus Haliday

Clinocentrus Haliday, Ent. Mag., 1: 266, 1833. Genotype, *Clinocentrus umbratilis* Haliday.

Neorhyssalus Baker, Philippine Jour. Sci., 12: 286, 1917. Genotype, *Neorhyssalus compositus* Baker. New synonymy.

It seems desirable in the course of this treatment of genera related to *Clinocentrus* to call attention to the synonymy indicated just above. The type of *Neorhyssalus compositus*, which is in the National Collection, is definitely a *Clinocentrus*.

Xenosternum, new genus

Resembles *Oncophanes* Foerster, but may be distinguished by the immargined prepectus, the location of the spiracles of the second and third abdominal segments above the acute lateral margins of the tergites, the incomplete notauli, and the exareolated propodeum.

Head transverse but not strongly so; face receding; vertex rather flat; occiput completely margined; maxillary palpi 6-segmented; labial

palpi 4-segmented; antennae long and slender; scape short; notauli weakly impressed anteriorly; mesopleurum with a longitudinal furrow; calcaria of posterior tibiae short; legs slender; radius originating from about middle of stigma; radial cell large; median cell narrowed toward base and apex; three cubital cells, the third much the longest, the second narrowing toward apex; first cubital and first discoidal cells separated; recurrent vein entering first cubital cell at apex very near first intercubitus; subdiscoideus arising from below middle of apex of first brachial cell; radiella wanting; postnervellus present but weak; basal abscissa of basella on a straight line with mediella; abdomen sessile; second and third tergites connate, the lateral margins acute, the suturiform articulation weakly indicated laterally; fourth and following tergites more or less retracted; ovipositor short but distinctly exserted.

Type of the genus, the following new species.

Xenosternum ornigis, new species

Female.—Length, 2 mm. Head in dorsal view less than twice as broad as long, weakly emarginate behind; eyes large; malar space shorter than basal width of mandible; face only slightly broader than length of combined face and clypeus, smooth; maxillary palpi as long as width of head; antennae longer than body, slender, 27-segmented in the type; scape short; the first flagellar segment the longest, three times as long as thick; the following gradually shorter but all at least twice as long as thick; frons and vertex finely coriaceous and subopaque; ocelli separated by about the diameter of one of them; postocellar line much shorter than ocellocular line and the latter but little more than half as long as the distance from posterior ocelli to occipital margin; occipital margin attaining level of upper eye margin; temples and cheeks gradually receding, smooth, less than half the width of eyes.

Thorax slightly narrower than head, about as wide as high; pronotum and mesoscutum finely shagreened and conspicuously hairy and opaque; scutellum flat; propodeum closely rugulose, with an irregular median longitudinal carina on basal half; mesopleurum smooth and polished, the longitudinal furrow sharply impressed and finely foveolate; stigma long, lanceolate; radius originating from just before middle of stigma; first abscissa of radius oblique, longer than width of stigma; second abscissa a little shorter than first intercubitus; third abscissa long, going to extreme apex of wing; recurrent vein about as long as first intercubitus and joining first cubital cell at extreme apex; first brachial cell open at extreme apex or only indistinctly closed; nervulus short, very slightly postfurcal; submediellan cell about half as long as mediellan; a single long bristle at junction of basella and subcostella.

Abdomen depressed, broadest at apex of third tergite, where it is at least as broad as thorax; first tergite barely longer than broad at apex, finely rugulose; combined second and third tergites gradually broadening behind, finely granular, smooth at apex; spiracles of second and third segments well removed from the acute lateral margin, third and following tergites smooth and polished; ovipositor sheath about as long as first abdominal segment.

Yellow; antennae brown; palpi yellowish white; wings hyaline; stigma yellowish hyaline; veins brownish; ovipositor sheath piceous.

Male.—Essentially like the female; antennae 26-segmented in the allotype; temples relatively broader and more convex than in the female; abdomen narrower, the segments beyond the third more exserted.

Type locality.—Manhattan, Kansas.

Type.—U. S. N. M. No. 50600.

Host.—*Ornix* species.

Described from 24 females and 22 males reared by L. M. Copenhafer, July and August, 1933.

Aulosaphes, new genus

Resembles *Oncophanes* Foerster, but differs in having the spiracles of the second and third abdominal segments above the acute lateral margins of the tergites, in the complete and strongly impressed suturiform articulation, and in the smaller second cubital cell. From *Xenosternum*, which is described above, it is distinguished by the margined prepectus and also by the complete suturiform articulation. In the structure of the thorax and abdomen *Aulosaphes* somewhat resembles *Lysitermus* Foerster and *Cedria* Wilkinson, but these two genera differ in having the subdiscoideus interstitial or nearly interstitial, and in addition the former lacks the first intercubitus and the latter the second, while both intercubiti are present in *Aulosaphes*. From all the genera with which it has been compared here the new genus is further distinguished by the depressed and denticulate apical margin of the third tergite.

Head strongly transverse, completely margined behind; eyes bare; temples narrow and receding; antennae long and slender; maxillary palpi 6-segmented, labial palpi 4-segmented; clypeus impressed anteriorly; thorax compact; notauli well marked anteriorly, the middle lobe of mesoscutum a little elevated in front; impression at base of scutellum large, shallow, divided by a low median ridge into two large foveae; propodeum with a sharply defined, narrow, median area extending from near base to apex; prepectus margined; mesopleural impression distinct; legs slender; posterior coxae small; calcaria of posterior tibiae short; stigma narrow, lanceolate, emitting the radius from near its middle; radial cell large; three cubital cells, the second much smaller than the third; both intercubiti distinct; recurrent vein interstitial or nearly; first brachial cell closed; subdiscoideus originating from middle of apex of first brachial cell; nervulus a little postfurcal; nervellus distinct; submediellan cell about half as long as mediellan; postnervellus weakly indicated; abdomen depressed, basal three tergites heavily sclerotized and longitudinally striate; following tergites very weakly sclerotized

and mostly retracted; first tergite with basal declivity sharply margined and with two nearly parallel keels near the middle extending from basal declivity to posterior margin; suturiform articulation strongly impressed, complete; apical margin of third tergite narrowly abruptly depressed, the margin itself denticulate except medially.

Type, *Rhyssalus unicolor* Ashmead, which was described from a single female specimen from the Philippine Islands.

Aulosaphes unicolor (Ashmead), new combination

Rhyssalus unicolor Ashmead, Proc. U. S. Nat. Mus., 28: 970, 1905.

The genotype may be separated as follows from the new species which is described below:

Eyes about as broad as face; malar space much shorter than basal width of mandible; frons finely transversely aciculate; third abdominal tergite with a large piceous area at base; ovipositor sheath longer than hind tibia; length, about 2.5 mm.....**psychidivorus,** new species

Eyes much narrower than face; malar space as long as basal width of mandible; frons smooth; third abdominal tergite without a piceous spot; ovipositor sheath definitely shorter than hind tibia; length, about 1.5 mm., **unicolor** (Ashmead)

Aulosaphes psychidivorus, new species

Female.—Length, 2.5 mm. Head transverse, a little broader than thorax; eyes very large, their transverse diameter about equal to width of face; malar space definitely shorter than basal width of mandible; face smooth and shining, clypeal fovea a little more than its diameter from eye margin; frons flat, finely transversely sculptured; postocellar line hardly as long as diameter of an ocellus and not more than half ocellocular line; temples flat, strongly receding; antennae as long as body, slender, tapering distinctly to apex, 23-segmented in type; all flagellar segments elongate, becoming only imperceptibly shorter toward apex of antenna; scape and pedicel short.

Thorax slightly depressed; notauli impressed but becoming weaker posteriorly; surface of mesoscutum minutely shagreened and subopaque; lateral anterior angles of middle lobe prominent; scutellum small, weakly convex, smooth and shining; median area of propodeum about three times as long as wide, acute at base, nearly parallel-sided on posterior two-thirds; laterad of median area propodeum smooth on basal half and finely transversely rugulose on posterior half; sides of pronotum, mesopleurum, and metapleurum smooth; mesopleurum without a distinct longitudinal furrow, the oblique suture along its posterior margin not foveolate; metapleurum hairy; stigma narrow, lanceolate, emitting the radius from slightly basad of its middle; first abscissa of radius definitely longer than the second and about as long as first intercubitus; second intercubitus weak; legs short, posterior tarsus not distinctly as long as posterior tibia.

Abdomen nearly as long as head and thorax, a little wider than thorax; first tergite slightly longer than broad at apex, longitudinally

striate, the distance between the parallel keels one and one-half times the width of the median area of the propodeum; second tergite broader and slightly longer than the first, transverse, longitudinally striate; second suture sharply impressed and foveolate; third tergite a little shorter than second, narrowing somewhat caudad, longitudinally finely striate like the first and second; ovipositor sheath very slender, a little longer than posterior tibia.

Brownish yellow; mandibles, palpi, antennae, and legs somewhat paler, wings hyaline, with a poorly defined transverse brownish band behind stigma; stigma brown, broadly yellow at base; narrow lateral margins of first and second tergites, the second suture, and a large transverse spot at base of third tergite blackish.

Male.—Essentially like the female.

Type locality.—Buitenzorg, Java.

Type.—U. S. N. M. No. 50601.

Host.—*Dappula tertia* (Templeton).

Described from four females and five males reared by R. Awibowo in April, 1929, and two males reared by the same investigator in July, 1929. In addition to the type series the National Collection contains three specimens, in poor condition, from Calamba, Philippine Islands, reared from a "psychid larva on cacao," March 5, 1925, by L. B. Uichanco. Paratypes in the Institute for Plant Diseases at Buitenzorg, Java.

LAC AND THE INDIAN LAC RESEARCH INSTITUTE, by DOROTHY NORRIS, P. M. GLOVER, AND R. W. ALDIS. Published by the Indian Lac Research Institute, Namkum, Ranchi, Bihar and Orissa, India, October, 1934. 53 pages, 12 illustrations. Price Rs. 2/8.

This work traces the position of the lac industry from the time the Indian Lac Research Institute was established shortly after the Great War until the present time. Entomologists will be interested in that portion treating with entomological history, distribution, cultivation and uses of lac.

The development of synthetic dyes ruined the cochineal trade and the Indian lac dye industry but uses were found for the resinous bye product known in the manufactured form as shellac. Although the phonograph, electrical and varnish industries use most of the output some is used in the hatting and confectionery trades, the emery wheel grinding and moulding industries, in finishing paper, leather, rubber and tinfoil, manufacture of sealing wax, lithographic inks, cements and glues, furniture, toys, munitions, fireworks and in photographic work.

Research on the biology of the lac insect, *Laccifer lacca* Kerr., has revealed a long list of natural enemies to be reckoned with before the actual crop obtained can be increased sixty-five percent and approach the possible hypothetical crop.

—B. J. L.

CULEX ROOTI, A NEW CULEX FROM PANAMA

(Diptera: Culicidae)

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Panama, R. de P.

On November 24, 1934, a number of mosquito larvae and pupae were collected from ground pools a few miles east of Panama City, R. de P. The mosquitoes found were *Anopheles neomaculipalpus*, Curry, *Culex conspirator*, Dyar & Knab., *C. iolambdis*, Dyar, *C. pilosus*, D. & K., and two male *Culex* of which no description could be found. Mr. W. H. W. Komp, who has recently had the opportunity to examine the types of the genus *Culex* in the U. S. National Museum, declared that this is a new species, and also made suggestions concerning the description. I am naming this mosquito in memory of the late Dr. F. M. Root, whose untimely death is deeply mourned by all those who have had the pleasure of knowing him and working with him.

Culex (Mochlostyrax) rooti, new species

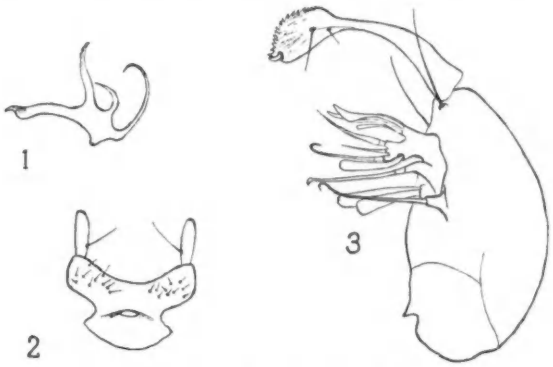
Clasper narrowed just before expanded "head," which is set at a slight angle with the plane of the shaft. "Head" not abruptly expanded, somewhat flattened dorsoventrally, the outer margin with a fine pilosity at crest, followed to the tip by a number of closely appressed triangular lamellae. Terminal horn very small; a short stout appendiculate spine inserted below and proximal to the tip of clasper. Two fine setae from tubercles arise from the outer aspect of the "head," the more distal being very fine and long. On the outer aspect of the "head" the membrane is finely striate, giving the appearance of sparse fine setae.

Side-piece rounded conical, somewhat flattened interiorly; a long coarse seta on inner aspect just below insertion of clasper; another situated on the dorsal side of the side-piece but having the appearance of being inserted at the base of the column of the outer division of the lobe of the side-piece. Whole surface clothed with long sparse setae, somewhat finer and more numerous on outer margin of outer curvature.

Outer division of lobe of side-piece with a short thick column bearing five appendages, or sets of appendages, all rather widely separated. The most proximal is a group of five appressed filaments; the smallest is curved, spatulate, with a slightly expanded truncate tip, about two-thirds the length of the others. The other four are widened just before the tip, there abruptly bent and narrowed to a point. The next most

proximal is a single stout flattened filament, with a central thickening, inserted on the outer aspect of the column, and slightly exceeding the five preceding filaments. Next in order is a fine, round, pointed filament with a long insertion, placed midway between the flattened filament and the long hook-tipped filament lying next to it, and about two-thirds the length of the latter. Inserted below and proximal to the hook-tipped filament is a large flattened filament, spatulate, infolded, striate, the shaft bent upwards from near the insertion, the tip rounded.

The inner division of the lobe of the side-piece is unique, resembling most closely that of *Culex innovator* Evans. The two usual filaments with capitate tips are present, but instead of being inserted at the tip of a column, or at most on two divergent arms of a column, as is usual, the column is divided into two distinct parts, which have migrated a considerable distance apart. The more distal column arises just



Culex rooti, new species; male
1, Inner mesosomal plate. 2, Ninth tergites. 3, Side-piece of male terminalia.

internal to and proximal to the column of the outer division of the lobe of the side-piece, and is short, about one-third the length of the nearly straight beak-tipped filament it bears. The more proximal column arises a little internal to and more proximal to the distal column, and is about half the length of the outer column, somewhat more slender, and bears a more slender beak-tipped filament slightly bent before the tip.

Just external to the inner column, and slightly nearer it than to the outer column, two subequal spatulate filaments arise from sessile insertions, being broader towards the tips, which are rounded, and resembling the large flattened striate filament on the outer division of the lobe of the side-piece.

The single element of the paired inner mesosomal plate is also unique. The stem is flattened laterally. From a lateral view, there is a long ventrally directed arm, with a striate downcurved pointed

tip and a lateral shoulder. The middle point is directed upwards nearly at a right angle to the outer arm, as long as it, thinner, not flattened, slightly sinuate, with an imbricated pointed tip, laterally directed. A third long, hornlike, delicate point arises dorsal to the middle point, near the attachment of the basal hook; it is about half as long as the middle point, curved nearly in a semicircle, with a sharp infuscated point directed laterally outward. The basal hook is very slender and curved. The single element of the paired outer mesosomal plates is long, roughly triangular, with an extended grooved articulation where the inner plate attaches. The upper edge is arcuate.

The tenth tergites are membranous, no setae being present, the tips striate and pointed.

The ninth tergites show a close similarity to those of *C. pilosus*. The body is broadly U-shaped; the arms of the U are flattened, infuscated, round-tipped columns, each bearing a single long seta, inwardly and upwardly directed, inserted slightly below the middle of the column on the inner side. At the inner curve of each arm of the U-shaped plate is a patch of about 10 fine setae. Integral with the U-shaped plate and extending cephalad from it is a low, conical membranous area, the tip of the cone squarely truncate, leaving a lacuna.

The tenth sternites are rather long and slender, with seven long slender pointed teeth.

The other parts of the terminalia show no characteristic features.

The eighth abdominal segment is incurved ventrally, forming a V-shaped trough to which the conical membrane bearing the lacuna is attached.

The type slides, number 50942, have been deposited in the U. S. National Museum.

PYRETHRUM FLOWERS, by C. B. GNADINGER. Published by McLaughlin Gormley King Co., Minneapolis, Minn., September, 1933. 270 pages, 39 illustrations. Price $3.50.

Within the last ten years considerable progress has been made in the use of certain plant derivatives as insecticides. Mr. Gnadinger presents the known facts regarding one of these, pyrethrum, and discusses its history, sources, value, chemistry and various uses. Outstanding because it is timely and authentic this work is of decided value to all whose professions or businesses require a knowledge of pyrethrum.

Care has been taken to present the material in a thorough manner and each of the heavier chapters dealing with the active principles of pyrethrum and the the chemical and biological methods involved are summarized. Frequent text references to more than 600 titles in the bibliography together with an adequate table of contents and a good index make references easy.

Well chosen illustrations not only carry the product from its sources through phases of preparation to application but also depict many pieces of apparatus used in rearing insects and testing materials.—B. J. L.

CULEX JUBIFER, A NEW SPECIES OF CULEX FROM PANAMA

(Diptera: Culicidae)

W. H. W. Komp and C. G. Brown[1]

Culex (Choeroporpa) jubifer, new species

Clasper constricted before "head." Slightly distad of constriction on outer aspect is a small conical point. Beyond this the outer aspect of the clasper rises high, dome-like, then produced to a narrow snout-shaped tip, with upturned terminal horn and terminal appendicle. Below the dome-like outer aspect arises a crest of many long setae, extending back to the conical point; the setae toward the end of the clasper are directed upward and forward, those toward the base directed upward and backward, the most basal being recurved. A short, stout eye-seta is on the outer aspect, being preceded by a smaller seta below it.

Sidepiece with large infuscated projecting lobe on outer aspect at apex, bearing 11 or 12 long strong setae from large insertions. On inner aspect, at apex, are two small slender setae.

Outer division of lobe of side-piece a stout column, bearing in order, beginning from the outer aspect, the following appendages: 3 flattened filaments, one longer than the others, with a central thickening; on column below them, on inner aspect, a single long fine seta; next to the filaments a single shorter pointed filament; then a long hook-tipped filament; inserted basad of this on lower aspect of column is a long stout rod-like filament with abruptly widened squarely truncate head.

Inserted on side-piece between the outer division of the lobe of the side-piece and the apex, arising from a separate elevation, is a very large infolded leaf, with large insertion and long thick stem, nearly as long as the leaf itself. The leaf is strongly ribbed, with the outer edge slightly irregular, and with pointed tip.

Inner division of lobe of side-piece a long column, bent upwards before tip, and directed laterally. Arising from the tip of the column is a long filament with expanded, slightly hooked tip. Inserted below this is a second filament with knobbed tip, not quite reaching tip of first filament. A patch of exceedingly fine pilosity is on inner aspect of base of column.

Tenth sternites with 7 to 9 strong curved teeth.

Inner paired plate of mesosome is T-shaped, the two arms inclined slightly upwards, forming an obtuse angle. Ventral arm flattened, with sharp point directed laterally. Dorsal arm terminating in a long hooked tip, also directed laterally.

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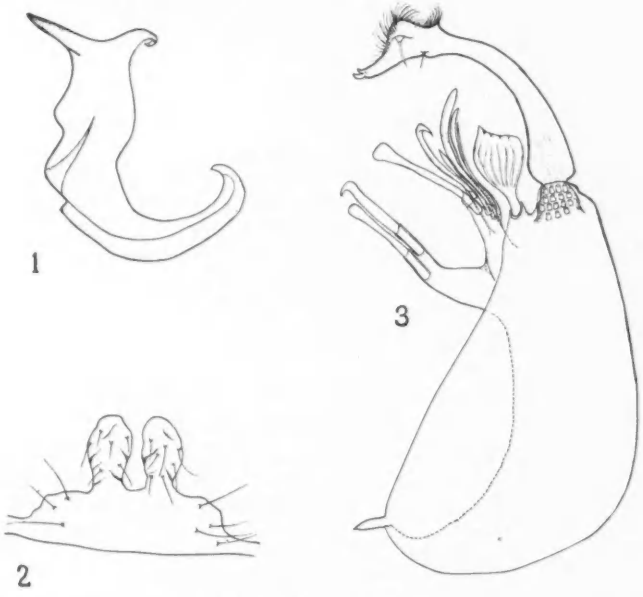
[1]From the Gorgas Memorial Laboratory, Panama, R. de P.

Ninth tergites distorted in mount, but apparently a pair of short, infuscated, wrinkled columns with slightly expanded tips, bearing sparse long setae except at the tips. These setae are unusual in that they are apparently all directed basad.



Culex jubifer, n. sp., male
1, Inner mesosomal plate. 2, Ninth tergite. 3, Side-piece of male terminalia.

Type: One male, the terminalia in a balsam mount. The material has been deposited in the U. S. National Museum.

The unique specimen was taken by sweeping with a net in Mojingo Swamp, between the lower Chagres River and Limon Bay, Canal Zone, by the junior author, in August, 1932.

The affinities of this species are difficult to determine. By the unique clasper, from which it takes its name (juba, the crest of a helmet), it is a Choeroporpa; the ridged leaf reminds one of those of Melanoconion; the 9th tergites resemble somewhat those of *Culex opisthopus* Komp, but the prominent setigerous lobe at the apex of the sidepiece and the peculiar club-like filaments of the inner division of the lobe of the side-piece are not similar to those of any known American Culex.

SOME PHYSIOLOGICAL EFFECTS OF CERTAIN ALIPHATIC THIOCYANATES ON THE ISOLATED HEART PREPARATION FROM THE ROACH, BLATTA ORIENTALIS

J. Franklin Yeager, Anna Hager and J. M. Straley,
Department of Zoology and Entomology, Iowa State College

This paper is a report of experiments on the effects of ten aliphatic thiocyanates on contraction rate and dilation of the isolated heart preparation from the roach, *B. orientalis*. Levy (1) described a physiological saline that would maintain active the isolated hearts of certain dipterous larvae for several hours. Yeager and Hager (2), utilizing a slightly modified Levy's solution, described a method for studying the contraction rate of the isolated insect (*B. orientalis*) heart, as well as of the Malpighian tubes, under controlled conditions of temperature, pH, osmotic pressure, O_2 supply, rate of renewal of saline and concentration of dissolved compound the effect of which is to be determined; they found that under optimal experimental conditions, contractions may continue at a nearly uniform rate for 6 or 7 hours. The method has been further utilized in these experiments.

MATERIALS

The thiocyanates employed are methyl thiocyanate, ethyl thiocyanate, isopropyl thiocyanate, n-propyl thiocyanate, butyl thiocyanate, trimethylene dithiocyanate, butylcarbitol thiocyanate, β, β', dithiocyanodiethylether, diethyleneglycol thiocyanate and diethyleneglycol dithiocyanacetate; they were used in chemically pure form.[1]

The animals utilized were well conditioned large nymphs and imagos of *B. orientalis*.

METHOD

The method consists essentially of dissecting off the animal's dorsal body wall, with its attached cardiac mechanism, pinning it dorsal side down to a wax strip, immersing the strip in modified Levy's solution (saline) in a side arm test tube and aerating by bubbling air or oxygen

[1]These compounds were prepared by Mr. J. M. Straley and Dr. L. C. Heckert, of The Kansas State Teachers College, Pittsburg, Kansas.

through the solution, which is thus made to circulate and which is renewed by drops of fresh solution from a pressure bottle, the excess solution being automatically and periodically removed by draining through the side arm. The test tube is immersed in a constant temperature water bath, the temperature of the solution being read from a thermometer. A diagram of the apparatus and a complete description of the method are given elsewhere (2).

The modified Levy's solution consists of 9.00 gms. NaCl, 0.70 gms. KCl, 0.46 gms. $CaCl_2$ and 1.0 gm. glucose, made up to a liter of solution with distilled water; pH was adjusted to 7.0–7.5 by adding a few drops of phosphate buffer solution. In these experiments it was found necessary to add acetone to the saline to dissolve the thiocyanates, the effects of which upon the tissues were to be observed. Two per cent, 0.2 per cent and 0.02 per cent acetone in saline, corresponding respectively to 0.06 per cent, 0.006 per cent and 0.0006 per cent thiocyanate were used. During a single experiment, two hearts were subjected to a single concentration of a given thiocyanate and its corresponding per cent of acetone. In all, four heart preparations were subjected to each concentration of each thiocyanate.

The rate of contraction was obtained by throwing a beam of light through the glass sides of water bath jar and test tube to the preparation, observing the latter through a horizontally arranged binocular dissecting microscope and, with a stop watch, taking the time required for the occurrence of ten complete contractions. This was repeated for a total of ten times and the averaged results, expressed as number of contractions per minute, taken as a measurement of contraction rate at that particular time. Determinations were usually made at 15 minute intervals throughout the duration of the experiment, which usually lasted 3 to 4 hours.

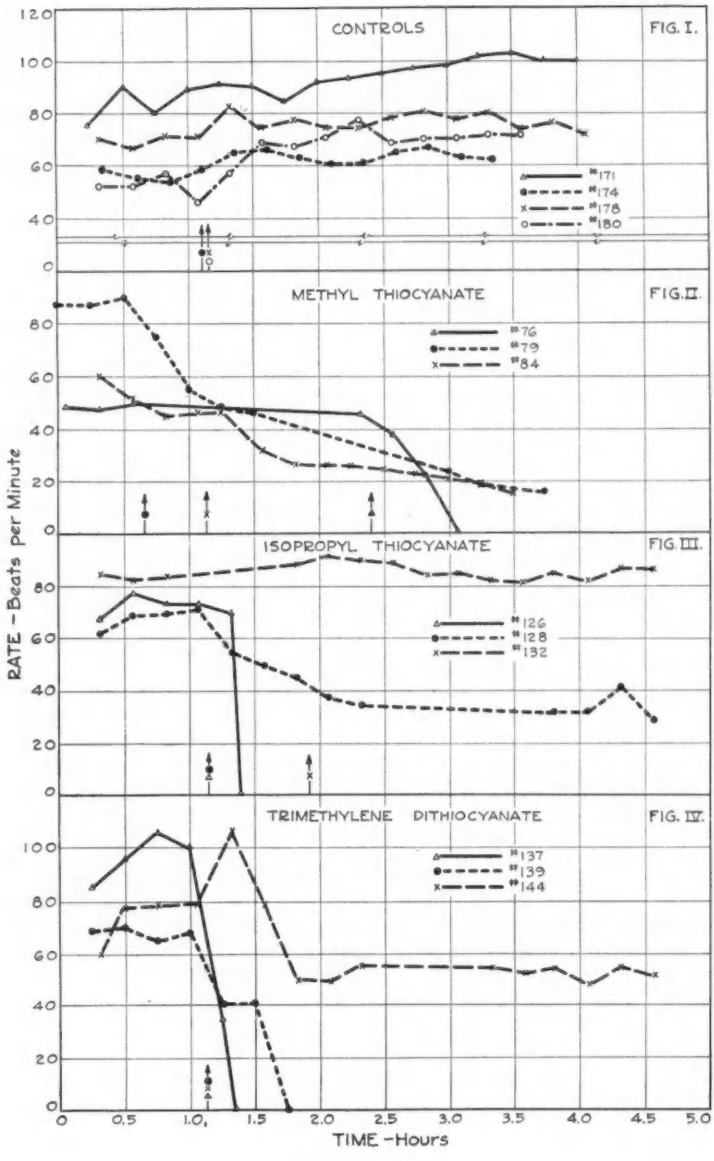
The routine procedure was to place the heart preparations in a test tube containing saline without either acetone or thiocyanate, for approximately an hour, during which contraction rates were measured at 15 minute intervals. The preparations were then quickly transferred to another test tube in which was saline containing a given concentration of a thiocyanate and its corresponding acetone concentration. Rate determinations were then continued to the end of the experiment.

A considerable number of control experiments were made; in these hearts were subjected to saline only and to 0.02, 0.2, 2.0, 3.0, 4.0 and 5.0 per cent concentrations of acetone in saline, only one concentration being used in a single control experiment.

Observations on changes in dilation of the heart were made and will be stated and discussed below.

RESULTS

Since it is not convenient to present all of the collected data, the results of representative experiments are shown in the graphs seen below. Fig. 1 gives the results of some of the control experiments. The curves show the rate of heart contraction, in number of beats per minute, plotted against duration of the experiment, in hours. These


CONTROLS
FIG. I.
°171
°174
°178
°180
METHYL THIOCYANATE
FIG. II.
°76
°79
°84
ISOPROPYL THIOCYANATE
FIG. III.
°126
°128
°132
TRIMETHYLENE DITHIOCYANATE
FIG. IV.
°137
°139
°144
RATE - Beats per Minute
TIME - Hours

FIGURES 1-4

rates show no marked fluctuation when the heart is immersed in saline only or in saline containing 2.0 per cent or less of acetone, although the trend of a given curve may vary from the horizontal. Three per cent acetone in saline usually produced an immediate marked but temporary reduction in rate, with occasional temporary cessation of contractions; 4.0 per cent acetone in saline usually caused an immediate, marked temporary cessation with occasional permanent (that is, for the duration of the experiment) cessation; and 5.0 per cent acetone in saline usually caused an immediate, marked cessation, with or without recovery during the experimental period. Arrows indicate the time at which the preparations were transferred from saline to saline-acetone solution.

In Figs. 1, 3 and 4 are curves similarly relating contraction rates to time intervals; the arrows indicate when the preparations were transferred from saline to saline-acetone-thiocyanate solution. In each case, the concentration of acetone and of thiocyanate as well as the temperature (usually about 28° C) and pH at which the experiment was conducted are indicated in the subscript to the figure. The thiocyanates used fall into three groups: a least effective group (group 2, Table I), an intermediately effective group (group 3, Table I) and a most effective group (group 4, Table I). These three groups are typified by methyl thiocyanate (Fig. 2), isopropyl thiocyanate (Fig. 3) and trimethylene dithiocyanate (Fig. 4), respectively.

A numerical value expressing decrease of contraction rate can be obtained by taking the slope of the straight line connecting the point

EXPLANATION OF FIGURES 1–4

Fig. 1. *Control experiments.* Isolated heart preparations subjected to saline and saline-acetone solutions and contraction rates measured, as described in text. In experiment No. 171, the heart preparation was subjected to saline only; in No. 178, to 0.02 per cent acetone in saline; in No. 180, to 0.2 per cent acetone in saline; and in No. 174, to 2.0 per cent acetone in saline. These curves represent typical experiments. These experiments are some of those given in Table I as group 1a; see text.

Fig. 2. *Methyl thiocyanate* effect on contraction rate. In experiment No. 84, the heart preparation was subjected to 0.0006 per cent thiocyanate in saline-acetone solution; similarly, in No. 79, to 0.006 per cent thiocyanate, and in No. 76, to 0.06 per cent thiocyanate. This compound represents group 2 (Table I). See text.

Fig. 3. *Isopropyl thiocyanate* effect on contraction rate. In experiment No. 132, the heart preparation was subjected to 0.0006 per cent isopropyl thiocyanate in saline-acetone solution; similarly, in No. 128, to 0.006 per cent thiocyanate, and in No. 126, to 0.06 per cent thiocyanate. This compound represents group 3 (Table I). See text.

Fig. 4. *Trimethylene dithiocyanate* effect on contraction rate. In experiment No. 144, the heart preparation was subjected to 0.0006 per cent dithiocyanate in saline-acetone solution; similarly, in No. 139, to 0.006 per cent dithiocyanate, and in No. 137, to 0.06 per cent dithiocyanate. This compound represents group 4 (Table I). See text.

For all figures: Contraction rate, in beats per minute (ordinates), is plotted against duration of the experiment in hours (abscissae). Temperature = 28.5° C. and pH = 7.0 to 7.5. Arrows indicate when the preparations were transferred from saline to saline-acetone solution or from acetone-saline solution to thiocyanate-acetone-saline solution.

on the rate-duration curve at which the preparation is transferred to the thiocyanate-acetone-saline solution and the last point on the same

TABLE I

AVERAGE SLOPES OF HEART RATE-DURATION CURVES

Groups	Control Experiments				Ave. Slopes	Sums
1a	Saline solution only (0% acetone)				—0.01	
	0.02 per cent acetone in saline				—0.04	
	0.20 per cent acetone in saline				—1.00	
	2.00 per cent acetone in saline				0.24	—0.81
1b	3.00 per cent acetone in saline				0.28	
	4.00 per cent acetone in saline				0.43	
	5.00 per cent acetone in saline				0.46	1.17
	Thiocyanate Experiments	Average Slopes				
	Compound Used	0.06% Th.* 2.0% A.*	0.006% Th. 0.2% A.	0.0006% Th. 0.02% A.	Sums	Sums†
2	Methyl Thiocyanate	0.99	0.47	0.38	1.84	2.64 (1.3)
	Ethyl Thiocyanate	0.37	0.42	0.01	0.80	
3	Isopropyl Thiocyanate	6.40	0.25	0.11	6.76	
	n-Propyl Thiocyanate	2.84	0.51	0.24	3.59	16.01 (5.3)
	Butyl Thiocyanate	4.94	0.47	0.25	5.66	
4	Trimethylene Dithiocyanate	5.35	2.90	0.13	8.38	
	Butylcarbitol Thiocyanate	6.73	2.63	0	9.36	
	β, β^1, dithiocyanodiethylether	5.28	2.05	0.61	7.94	44.21 (8.8)
	Diethyleneglycol Thiocyanate	6.50	3.80	0.13	9.93	
	Diethyleneglycol Dithiocyanacetate	5.51	2.88	0.21	8.60	

*Th. = Thiocyanate compound and A. = acetone, in a given saline solution.
†Of groups; number in parenthesis equals group sum divided by the number of compounds in the group.

curve. Although this value is only an approximate measure of the general trend of the curve and tells nothing of variations between the two points, it may be used to indicate the general effect of the thio-

cyanate used; the greater the slope value, the greater is the inhibitory effect on heart rate. The slopes of all curves obtained have been calculated and the mean value for each concentration of each thiocyanate as well as each control are given in Table I, which also gives the sums of slopes for each compound, the sums of the slopes for a given group and the latter divided by the number of thiocyanates per group (given in parentheses). Group 1a includes the acetone concentrations actually used to dissolve the thiocyanates while group 1b includes the higher concentrations of acetone in saline not so used.

Thus far, reference has been made to the effects of the thiocyanates on contraction rate only; the rate was determined as long as contractions could be detected anywhere in the heart, even though only a portion of the heart could be observed to pulsate. Often diameter increased while contractions continued, rate seeming to bear no definite relation to diameter, for in some cases the heart could be observed to dilate more widely during diastole and to constrict to less than the normal extent during systole, without an accompanying change in rate. At times the increase of dilation was so marked that careful observation was necessary to determine whether contractions were occurring at all, in which case it might be found that the contraction rate may or may not have changed. Usually, when contractions were completely stopped, either locally or throughout the entire heart, by a thiocyanate solution, the tubular heart wall was found to be stopped in diastole, widely dilated.[2]

As usually observations were not continued longer than 3 to 4 hours, these experiments tell nothing as to the eventual inhibition or recovery of the preparation when the compounds are applied over longer periods of time.

DISCUSSION

From Fig. 1 and Table I, group 1a, it can be seen that, in general, acetone of 2.0 per cent or less concentration in the physiological saline has a negligible effect upon contraction rate of the isolated heart preparation used in these experiments, although a marked but temporary inhibitory effect may be produced by certain higher concentrations (group 1b). This indicates that in the thiocyanate experiments the acetone used as solvent for the three thiocyanate concentrations is without appreciable effect *per se* upon rate and that the change in rate is indicative of a thiocyanate effect.

As typified by the figures and as indicated by the slopes and their sums in Table I, the ten thiocyanates used fall readily into the three groups, already mentioned, having different degrees of inhibitory effect on contraction rate. In group 2, methyl thiocyanate is somewhat more effective than ethyl thiocyanate: but its effect in 0.06 per cent concentration is represented by an average slope value (Table I, Fig. 2) of only about 1.0. Compared with this the 0.06 per cent concentration of the compounds of group 3 are much more effective, as indicated by mean slope values of from 2.84 to 6.4 (Table I, Fig. 3).

[2]Pyrethrum, similarly applied, was found to stop the heart in systole.

The sums of the slope values (Table I, last column) for these two groups differ greatly because of additive effects of the individual values and, when divided by the number of compounds per group (Table I, last column, parentheses) can be taken to indicate the inhibitory effects of the groups as wholes. Within group 3, n-propyl thiocyanate is considerably less effective in 0.06 per cent concentration than the other two compounds. In general, the difference of effects by the three concentrations of a given compound can be readily distinguished graphically, as shown by isopropyl thiocyanate in Fig. 3.

It should be emphasized that groups 2 and 3 differ most markedly in the 0.06 per cent thiocyanate concentration, but the same can not be said of groups 3 and 4. As shown by Figs. 3 and 4 and by Table I, these two groups differ most markedly in the 0.006 concentration. The 0.06 per cent concentrations of groups 3 and 4 have very similar inhibitory effects, causing almost immediate cessation of contractions; and a not very different effect is shown by the 0.006 per cent concentration of group 4. The 0.0006 per cent concentration of group 4, with the possible exception of β, β', dith iocyanodiethylether, appears to be no more effective than the same concentration in the other groups.

Considering the three groups together it would appear that essentially the maximum inhibitory effect on contraction rate is not produced by group 2 but is produced by the highest concentrations of groups 3 and 4, the intermediate concentration of group 4 producing nearly as marked an effect. In lowest concentration, the compounds of the three groups have little or no effect on rate. Groups 2 and 3 differ most markedly in the highest and groups 3 and 4 in the intermediate concentrations. Speaking approximately, it may be said that the effectivenesses of groups 2, 3 and 4 differ about as 1 : 5 : 9 (Table I). In general, these thiocyanates cause a decrease or cessation of rate and an increase in dilation of the heart.

Although these experiments and observations indicate that the thiocyanates used can produce two different effects on the isolated heart preparation, that is, a change in rate and a change in dilation, they yield little information as to the mechanism underlying these effects. Little is known concerning the regulatory mechanism of the insect heart and no satisfactory guess can be made here as to how these compounds alter the contraction rate but a possibility can be suggested as to how they may affect an increase in diameter of the heart. There exists evidence (3, 4, 5, 6, 7) that some thiocyanates can produce a state of increased contraction in vertebrate muscle. There exists also the hypothesis (8) that one function of the alary muscles of certain insects is to cause diastole during the cardiac cycle; this would mean either that the alary muscles actively (isotonically) contract to produce each cardiac diastole or that they maintain, in opposition to the cardiac muscles proper, a given state of contraction (myotonus), the tension of which is applied to the walls of the tubular heart, keeping the latter dilated. There exists also the readily observed facts (1) that, when the alary muscles are sectioned or when the heart is removed from its dorsal wall attachments, the heart passes immediately into a sustained or tetanic contraction and (2) that a given thiocyanate

applied to the heart attached or unattached to its dorsal wall produces, respectively, increased dilation or no obvious effect at all[3]. With these statements in mind, the idea arises that perhaps the thiocyanates produce their effect of increased heart dilation by causing an increased tonus in the alary muscles rather than by causing a decreased tonus of the cardiac muscle fibers. This possibility is suggested tentatively as a working hypothesis, which serves at least to explain the observations made in these experiments in terms of effects reported to be produced by certain thiocyanates in other muscles. It should be noted that the results of these experiments tend to support but do not prove the suggested mechanism of dilation, proof or disproof of which must depend upon further investigation of the cardiac mechanism in this animal.

SUMMARY AND CONCLUSIONS

1. The isolated insect heart method previously described has been used in a study of the effects of dissolved chemical compounds (aliphatic thiocyanates) on contraction rate; for conditions of temperature, etc., see text.

2. Contraction rate of the isolated heart preparation is not significantly affected by 2.0 per cent or less concentration of acetone in physiological saline, although higher concentrations may produce inhibitory effects.

3. The ten aliphatic thiocyanates, used in 0.06, 0.006 and 0.0006 per cent concentrations, tend to inhibit contraction rate and fall into three groups, differing in effectiveness of inhibition roughly as 1 : 5 : 9. The least effective group includes methyl and ethyl thiocyanates, the intermediately effective group includes isopropyl, n-propyl and butyl thiocyanates and the most effective group includes trimethelene thiocyanate, butylcarbitol thiocyanate, β, β', dithiocyanodiethylether, diethyleneglycol thiocyanate and diethyleneglycol dithiocyanacetate.

4. In general, the 0.0006 per cent thiocyanate concentrations were without significant effect on rate; the 0.006 per cent concentration of the most effective group caused rapid decrease in rate and eventual cessation of contractions; and the 0.06 per cent concentrations of both intermediately and most

[3]If one sections, in a single body segment, the alary muscles of an isolated heart (*P. americana*) preparation in modified Levy's solution, the portion of the heart in that segment undergoes a marked decrease in diameter, although the heart anterior and posterior to that segment may remain normally dilated and continue to contract. If then the heart be stopped with butylcarbitol thiocyanate, the heart between the sectioned alary muscles remains constricted while, at the same time, the heart anterior and posterior to that region becomes widely dilated. The simplest interpretation of these results is that the thiocyanate caused cardiac dilation by increasing the myotonus of the alary muscles.

effective groups produced an almost immediate cessation of contractions.

5. Methyl is more effective than ethyl thiocyanate.

6. In general, the thiocyanates tend to increase the degree of dilation of the heart, attached to its dorsal body wall as in these experiments.

7. The observations described are in agreement with the tentatively suggested hypothesis that the thiocyanates produce an increased heart dilation by causing an increased tonus of the alary muscles.

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LIBELLEN ODER WASSERJUNGFERN (ODONATA), by Dr. Eduard May (Göttingen), pp. 1–124 with 134 text figures, 1933. Published by Gustav Fischer, Jena, as Part 27 of Die Tierwelt Deutschlands. Price, RMK. 10 ($5.00).

This is the best brief summary on the dragonflies of central Europe. It is well enough illustrated to make its use a comfort and is very thoroughly documented. For once we have a work which is not padded with lists of illustrations. It has a simple Inhaltsübersicht of two pages and an index of six pages. Twenty pages are given to anatomy and biology, sixty are devoted to adult forms and fifty pages to larvae. The descriptions are reduced to selected specific characters.

This is one of the series of volumes on the fauna of Germany published under the general title "Die Tierwelt Deutschlands." Its brevity does not reveal the great amount of literature that had to be evaluated by the author whose writings on this order of insects are well known. Students of the Odonata are to be congratulated on the fact that this work has been done so ably and conscientiously.

—C. H. K.

NEARCTIC SPIDERS OF THE FAMILY UROCTEIDAE

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The family Urocteidae is represented in the Nearctic fauna by only three known species. All of these belong to the subfamily *Oecobiinae*. One species (*Oecobius parietalis* (Hentz) is common across the southern United States, and is well known; the other two species are less common, and are little known: *Oecobius isolatus* Chamberlin was described from an immature specimen from Lower California, Mexico; an immature specimen has since been collected in Arizona. *Platoecobius floridanus* (Banks) was described from Florida; an examination of additional specimens from the Okefinokee Swamp in Georgia indicate that it constitutes a new genus separate from *Oecobius*, where it has been placed.

There has been some difference of opinion as to whether genera *Oecobius* and *Uroctea* should be placed in the same family or maintained in separate families. Simon (*Hist. Nat. Ar.*, Vol. I) definitely separated the two, when he separated his suborder Araneae Verae into two main sections, Cribellatae and Ecribellatae, on the basis of the presence or absence of a cribellum and calamistrum. He remarked, however, on the extreme similarity of the two families. The presence or absence of the cribellum and calamistrum has since been shown to be of much less significance. They are primitive characters and have undoubtedly been lost on several independent occasions in the phylogeny of different branches. Petrunkevitch, in his later works on the families of spiders, prefers to consider the presence or absence of a cribellum and calamistrum as sufficient to distinguish between families in all cases, but not between larger groups.

The Urocteidae and Oecobiidae show such striking similarity in all other features, external and internal, that it seems apparent that the presence of the cribellum and calamistrum should be reduced to subfamily importance in this particular instance. The presence of a colulus in *Uroctea* indicates that the cribellum is merely in a late stage of degeneration. The Urocteidae and Oecobiidae form an isolated group, with several striking features in common. They certainly show much less

difference than is manifested within certain other families. It is, therefore, considered proper here to combine the two into one family, as others have previously done. Since *Urocteidae* is the older name, it must be used for the family.

The position of the Urocteidae, in relation to the other families, has never been determined with any certainity. It is probably a primitive type near the base of the Agelenid branch. Family characters of the Urocteidae are given as follows:

Family **Urocteidae**

Carapace wider than long; sides rounded; without thoracic groove. Eyes arranged in two rows in a close group near the center of the head; heterogenous. Chelicerae slender, without fang-groove or teeth; contiguous for full length; without boss or scopula; fang simple, curved, sharp. Sternum wider than long; separating hind coxae. Labium free. Endites well developed; lobes convergent; without scopula. Palpus of female stout, with a pectinate claw. Palpus of male with well-developed palpal organ on ventral side of cymbium. Legs subequal in length; claws three, pectinate; spines few or lacking. Abdomen more or less flattened. Hind spinnerets with terminal segment long, basal segment short; front spinnerets short; middle spinnerets between the others, in the usual position, of moderate size. With cribellum and calamistrum, or colulus. Postabdomen large, two-jointed, with a distinctive fringe of long hairs. Heart with three pairs of ostia. Respiratory system consists of one pair of lungs, and one tracheal spiracle close to the spinnerets; tracheal tubes restricted to the abdomen.

The subfamilies and genera may be separated thus:

A. Without a cribellum and calamistrum; over 5 mm. in length (UROCTEINAE) ..... **Uroctea**
B. With cribellum and calamistrum; decidedly less than 5 mm. in length. (OECOBIINAE).
   1. Median ocular area as long as, or longer than, wide; tibial index[1] of leg I of female less than 16 ..... **Oecobius**
   2. Median ocular area much wider than long; tibial index of leg I of female more than 16 ..... **Platoecobius**

Subfamily **Urocteinae**

Without cribellum and calamistrum; colulus present. Relatively large, usually over five millimeters in length.

Single genus, *Uroctea* Dufour, 1820. Genotype—*U. durandi* (Latreille).

No representatives in the Western Hemisphere.

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[1]The tibial index here used is derived according to the formula proposed by Petrunkevitch, *Trans. Connecticut Acad. Arts and Sciences*, 30: 10–11, 1929.

Subfamily **Oecobiinae**

With cribellum and calamistrum; calamistrum double, there being two rows of hairs. Spiders relatively small, being usually from two to three millimeters in length.

Two genera: *Oecobius* Lucas, 1845. Genotype—*O. cellariorum* (Duges). *Platoecobius*, gen. nov. Genotype—*P. floridanus* (Banks).

Both genera are represented in North America.

Genus **Oecobius** Lucas, 1845

Synonyms: *Omanus* Thorell, 1870. Genotype, *O. navus* (Blackwall).
Thalamia Hentz, 1850. Genotype, *T. parietalis* Hentz.

Carapace wider than long; sides rounded; clypeus narrow across front and protruding. Head moderately elevated; the highest part being in the region of the posterior median eyes; carapace sloping from eyes in all directions. Eyes arranged in two rows near the center of the head; both rows typically procurved; median ocular area longer than wide, or at least, not wider than long; anterior median and posterior median eyes dark, others pearly and lusterous; posterior median eyes irregular in shape, others round.

Chelicerae slender, narrowing distally; contiguous throughout length; fang-groove and teeth lacking; fang curved, sharp. Sternum wider than long; somewhat heart-shaped; posterior tip separating hind coxae. Labium wider than long, rounded. Endites convergent around labium. Palpi of female moderately stout. Legs moderately stout; spines few or lacking.

Abdomen ovate, moderately flattened. Cribellum partially divided. Front spinnerets short, widely separated; hind spinnerets with a short basal segment and a long terminal segment. Postabdomen moderately large.

Our two species may be separated thus:

1. Carapace light with dark markings (Page 267).....**O. parietalis**
2. Carapace entirely dusky or black (Page 270).....**O. isolatus**

Oecobius parietalis (Hentz)

(Pl. I, Fig. 1; Pl. II, Figs. 3–10; Pl. III, Figs. 11–21)

Thalamia parietalis Hentz. Jour. Boston Soc. Nat. Hist., 1850, p. 35; Pl. VI, Fig. 16. (Reprint: Spiders U. S., p. 141; Pl. XV, Fig. 16.)
Thalamia parietalis Banks. Proc. Ent. Soc. Washington, 2: 125, 1890.
Oecobius parietalis Simon. Hist. Nat. Ar., 1: 247, 1892.
Oecobius parietalis Emerton. Trans. Connecticut Acad. Arts and Sci., 14: 212, 1909. Pl. 8, Fig. 1.
Oecobius parietalis Comstock. Spider Book, 1912, p. 288, Figs. 273–275.
Oecobius parietalis Crosby and Bishop. Jour. Elisha Mitchell Sci. Soc., 41: 173.
Oecobius parietalis Petrunkevitch. Trans. Connecticut Acad. Arts and Sci., 30: 75, 1929.

Female: Cephalothorax wider than long; basal margin broadly concave, sides rounded; clypeus narrow across front, slightly protruding; median groove lacking. Eyes on top of cephalic elevation;

carapace sloping away from eyes in all directions. Eyes subequal. Posterior median eyes irregular in shape, others round. A. M. and P. S. eyes dark; A. S. and P. M. eyes pearly, lusterous. Both rows procurved; posterior row faintly longer than anterior row. A. M. eyes a diameter, or slightly less, apart; subcontiguous with the lateral eyes. P. M. eyes a short diameter or less apart; closer to the lateral eyes. Median ocular area longer than wide, about as wide in front as behind. Median eyes of the two rows a little more than a diameter of an A. M. eye apart. Lateral eyes on each side a radius, or a little more, apart. (Eye relations show some variation between individuals; Figures 9 and 10 show two variations near opposite extremes, Figure 9 being more typical for the male, and Figure 10 being more typical for the female; intergradations are common for both sexes.)

Chelicerae slender, narrowing distally; contiguous throughout length; fang groove and teeth lacking; fang simple, curved, sharp. Sternum wider than long; widest between second and third coxae; anterior corners rounded; slightly concave in front at middle; rounded point behind seperate hind coxae by a diameter or slightly less. Labium wider than long, rounded. Endites well-developed; convergent around labium; contiguous at tips. Palpus moderately stout, with pectinate claw at tip.

Legs stout, subequal in length; tibial index, I–14.7, IV–14.0. Claws all pectinate; third claw well-developed. Calamistrum double, extending about half length of metatarsus, on basal half. A few weak spines on metatarsi and tarsi; best developed on hind leg (see Fig. 15), reduced on anterior legs.

Abdomen somewhat flattened; longer than wide; sides rounded, widest near middle or slightly behind middle; anterior end rounded, sometimes slightly emarginate; posterior end bluntly pointed. Postabdomen conspicuous, pointed posteriorly, with an even fringe of long curving hairs. Cribellum partially divided. Front spinnerets short, widely separated; hind spinnerets with basal segment short, terminal segment long, bluntly pointed, and with a row of tubules on a mesoventral line. Epigynum with a narrow, pointed, median, finger-like process containing a pair of tubes.

Clothed with coarse hairs, except on carapace.

Color: Cephalothorax with all parts and appendages pale straw yellow, with dark markings distributed as follows: Carapace with a black border on sides; clypeal region dusky to black, with the tip of the clypeus light; median region, including the eyes, dusky, extending posteriorly to the margin (region immediately around the eyes black); three large black dots in a curved row on each side of thorax. Endites and chelicerae unmarked; labium dusky; sternum unmarked, paler than other parts. Legs marked with broad black rings, which are usually more or less broken up into spots, distributed thus: one on trochanter; two on femur—near middle and at distal end; one on patella; two on tibia; two on metatarsus. Tarsus shaded on distal half. Palpus with three bands: one on tip of femur; one on patella, and one on tibia; tarsus unmarked.

Abdomen whitish marked with black or dusky, in a broken and more or less irregular pattern, as shown in Figures 1, 11 and 12 (the

white areas are broken up into small irregular spots on preserved specimens). Venter pale with sides blackish; black at sides of spinnerets extending mesally, and anteriorly along middle of venter in two dusky strips. Spinnerets pale, with black spot on side of front spinnerets, and hind spinnerets with terminal segment largely dusky or black. (Dark specimens have the black markings heavier and more intense; light specimens (see Fig. 11) have the markings reduced and less intense.)

Male: Similar to female in color and structure, with these differences in structure: eye group slightly closer together; carapace slightly shorter in proportion to width; clypeal projection narrower and more pointed; abdomen much smaller and narrower; spinnerets slightly smaller; fringe on anal tubercle often less developed. Palpus of moderate size, structures as shown in Figure 19–21. Tibial index, I–13.5, IV–12.5.

Measurements:

FEMALE

Length, 2.6 mm.
Cephalothorax: Length, 0.9 mm.; width, 1.0 mm.
Abdomen: Length, 1.8 mm.; width, 1.4 mm.

Legs:	I	II	III	IV	*Palpus*
Coxa	0.36 mm.	0.36 mm.	0.33 mm.	0.33 mm.	.....
Trochanter	0.10	0.10	0.10	0.10	0.08 mm.
Femur	1.00	1.00	1.00	1.00	0.40
Patella	0.33	0.33	0.33	0.38	0.20
Tibia	0.73	0.80	0.75	0.80	0.20
Metatarsus	0.73	0.75	0.73	0.87	....
Tarsus	0.57	0.59	0.50	0.50	0.40
Total	3.82	3.93	3.74	3.98	1.28

MALE

Length, 2.0 mm.
Cephalothorax: Length, 0.83 mm.; width, 0.93 mm.
Abdomen: Length, 1.33 mm.; width, 0.80 mm.

Legs:	I	II	III	IV	*Palpus*
Coxa	0.33 mm.	0.33 mm.	0.31 mm.	0.33 mm.	.....
Trochanter	0.11	0.11	0.11	0.11	0.07 mm.
Femur	0.87	0.90	0.83	0.91	0.40
Patella	0.33	0.33	0.31	0.33	0.20
Tibia	0.66	0.73	0.73	0.83	0.12
Metatarsus	0.60	0.73	0.73	0.83	....
Tarsus	0.50	0.57	0.40	0.50	0.53
Total	3.40	3.70	3.42	3.84	1.32

These small spiders are found mostly in the warmer parts of the United States. They inhabit buildings, live on walls and fences, or under rocks and debris. In houses they most commonly frequent the windows and under sides of furniture. At Palo Alto, California, they are common about the buildings of Stanford University; they build their small, flat webs in corners of windows, or on the outside of the buildings between the bricks; mature individuals of both sexes were common during July of 1932. They hide behind their webs when inactive. The webs are small and flat, being about an inch

or two across. They are attached at the edges, and have several openings through which the spider may leave and enter. The spiders do not cling to the webs, but stand on the surface under the web, with their backs to the web. They run very rapidly, and escape by darting into cracks or other small openings.

Type locality: Alabama. *Other localities:* Louisiana: New Orleans, Baton Rouge. Florida. District of Columbia: Washington. Massachusetts: Boston. California: Los Angeles and vicinity, Laguna Beach, San Diego, San Luis Obispo, Pacific Grove, Palo Alto, Berkeley. Mexico: Lower California.

Oecobius isolatus Chamberlin

(Plate I, Fig. 2)

Oecobius isolatus Chamberlin. Proc. California Acad. Sci., 4 ser., 12: 584, 1924.

Immature: Shape essentially the same as that of *parietalis*. Size, when mature, probably about the same as that of *parietalis*.

Color: Carapace entirely blackish. Chelicerae, endites and labium pale yellowish with dusky markings; sternum entirely dusky. Legs and palpi whitish, the legs heavily annulated with black; palpi with a small dusky mark on femur above, and tip of tarsus shaded. Abdomen whitish with a black color pattern above. (Figure 2 shows the nature of the color markings, but is partially restored and may not be exact in all details.) Venter whitish.

Type locality: Carmen Island, Gulf of California (Mexico). *Other locality:* Arizona: Sycamore Creek (March, 1930, R. V. Chamberlin, Jr.), one immature.

Genus **Platoecobius** Chamberlin & Ivie, new

Carapace flattened, wider than long, sides rounded; clypeus slightly protruding; eyes on front of cephalic elevation, from which the carapace slopes in all directions. Eyes in two rows; P. M. eyes widely separated, and near the lateral eyes; median ocular area much wider than long; posterior median eyes irregular in shape, others round.

Chelicerae as in *Oecobius*, but shorter. Sternum slightly wider than long; somewhat heart-shaped; posterior tip separates hind coxae. Labium wider than long. Endites convergent around labium, contiguous at tips. Legs stout, proportionately shorter than in *Oecobius;* without spines. Abdomen flattened; broadly ovate. Postabdomen large, with characteristic fringe of long hairs. Spinnerets large, in general similar to those of *Oecobius*. Cribellum apparently not divided.

Platoecobius floridanus (Banks)

(Plate IV, Figs. 22-32)

Thalamia floridana Banks. Trans. American Ent. Soc., 23: 58, 1893.
Oecobius floridanus Petrunkevitch. Catalogue of American Spiders, 1911, p. 114.

Female: Cephalothorax low, elevated in the head region, from which the carapace slopes in all directions; slightly wider than long;

sides rounded. Eyes situated in a transverse group on the front of the cephalic elevation. Rows of about equal length, the posterior row being faintly the longer. Anterior row decidedly procurved (also appears procurved from dorsal view); posterior row slightly procurved. A. M. eyes somewhat more than one diameter apart; less than a radius from the side eyes; subcontiguous with the P. M. eyes. P. M. eyes nearly three short diameters apart; subcontiguous with the lateral eyes. Lateral eyes about a radius apart. Median ocular area nearly twice as wide as long, much wider behind than in front. Eyes subequal in size. A. M. eyes dark; P. M. eyes light, pearly; A. S. and P. S. eyes similar in color, pale, but not lusterous like the P. M. eyes.

Sternum large, slightly wider than long; nearly straight across front, broadly rounded at sides; obtusely pointed behind, narrowly separating hind coxae. Chelicerae straight, slender, shorter than in *Oecobius*. Labium wider than long. Endites convergent around labium; lobes contiguous at the tips. Palpus stout with a distinct pectinate claw. Legs short and thick; tibial index: I–16.9, IV–16.5; without spines; claws three, pectinate. Cribellum double, extending full length of metatarsus.

Abdomen much flattened; broadly ovate. Postabdomen large, oval, with characteristic fringe of long hairs. Spinnerets large; front pair short, widely separate; hind pair with basal segment short, terminal segment long and pointed. Cribellum apparently not divided.

Legs covered with long coarse hairs; abdomen covered with heavier hairs, with a basal fringe of long hairs. Several setae on head. Sternum and mouthparts clothed with shorter hairs.

Color: Carapace, legs and palpi dull pale yellowish, marked with dusky gray: carapace with a broad border of dusky gray; cephalic elevation bordered with dusky; clypeus dusky; eyes surrounded by black. Legs heavily shaded with large patches of dusky gray; coxae pale. Chelicerae and endites pale yellowish, endites whitish at tips. Labium more dusky. Sternum nearly white, with a narrow blackish border. Abdomen dark gray with dorsal mid area broadly faded; venter pale, whitish. Anal tubercle and hind spinnerets dusky; others pale. Epigynum is as shown in Figure 30.

Measurements:

Length: 2.2 mm.

Cephalothorax: Length, 0.8 mm.; width, 0.93 mm.

Abdomen: Length, 1.53 mm.; width, 1.33 mm.

Legs:	I	II	III	IV	*Palpus*
Coxa	0.33 mm.	0.33 mm.	0.33 mm.	0.33 mm.	.....
Trochanter	0.10	0.10	0.10	0.10	0.07 mm.
Femur	0.73	0.73	0.66	0.66	0.33
Patella	0.37	0.37	0.33	0.37	0.20
Tibia	0.50	0.52	0.47	0.48	0.20
Metatarsus	0.39	0.40	0.40	0.48	....
Tarsus	0.37	0.37	0.32	0.33	0.40
Total	2.79	2.82	2.61	2.75	1.20

Type locality: Lake Worth, Florida. (Type, female in collection of M. C. Z., Harvard). *Other locality:* Okefinokee Swamp, Georgia (August 1933, W. Ivie), female and immature.

The specimens collected in Georgia were found under the scales of bark on a large pine in Okefinokee Swamp. Their flat bodies correlate very well with their choice of habitat. They were quick in their movements, and most of them observed escaped into crevices in the bark. They apparently had no webs.

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EXPLANATION OF PLATES

Plate I

Fig. 1. *Oecobius parietalis* (Hentz).[2] Female, dorsal view.
Fig. 2. *Oecobius isolatus* Chamberlin. Immature, dorsal view.

Plate II

Fig. 3, *Oecobius parietalis* (Hentz). Male, dorsal view. Fig. 4, Female, Front. Fig. 5, Female, lateral view. Fig. 6, Male, lateral view. Fig. 7, Male, ventral view. Fig. 8, Female, ventral view. Fig. 9, Male, eyes from dorsal view. Fig. 10, Female, eyes from dorsal view.

Plate III

Fig. 11, *Oecobius parietalis* (Hentz). Female, dorsal view of a light colored specimen. Fig. 12, Female, abdomen from a dark colored specimen. Fig. 13, Female palpus, mesal view. Fig. 14, Chelicera, posterior view. Fig. 15, Terminal segments of leg IV, showing double calamistrum and spines. Fig. 16, Female, foot of leg I. Fig. 17, Spinnerets of female, ventral view. Fig. 18, Epigynum. Fig. 19, Male palpus, ventral view. Fig. 20, Male palpus, mesal view. Fig. 21, Male palpus, ectal view.

Plate IV

Fig. 22. *Platoecobius floridanus* (Banks). Female, dorsal view. Fig. 23, Female, lateral view. Fig. 24, Female, ventral view. Fig. 25, Chelicera of female, posterior view. Fig. 26, Foot of female, lateral view. Fig. 27, Tip of palpus of female. Fig. 28, Front of female. Fig. 29, Eyes of female, dorsal view. Fig. 30, Epigynum. Fig. 31, Spinnerets of female, ventral view. Fig. 32, Metatarsus IV, showing calamistrum.

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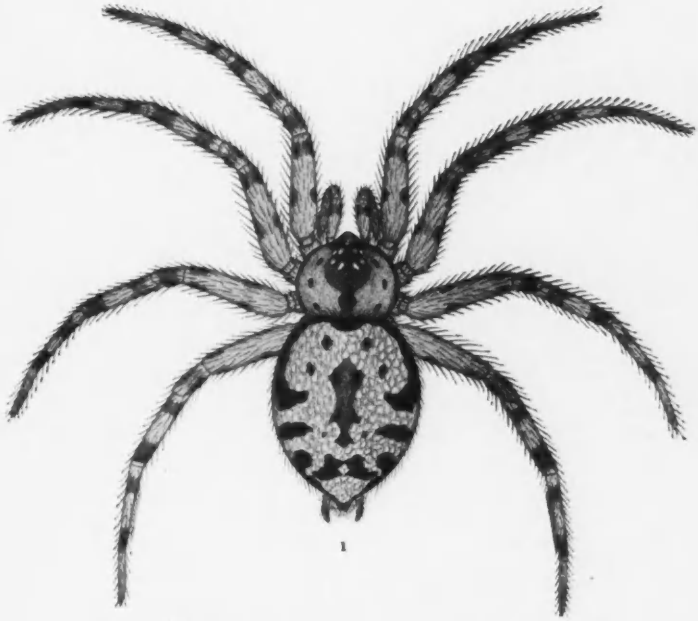
[2]Figures 1, 2, 3, 5, 6, 7, 8, 11, 12, 22, 23, and 24 are all drawn to the same scale.



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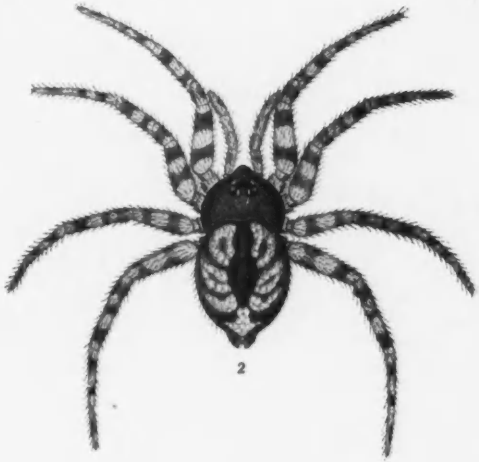

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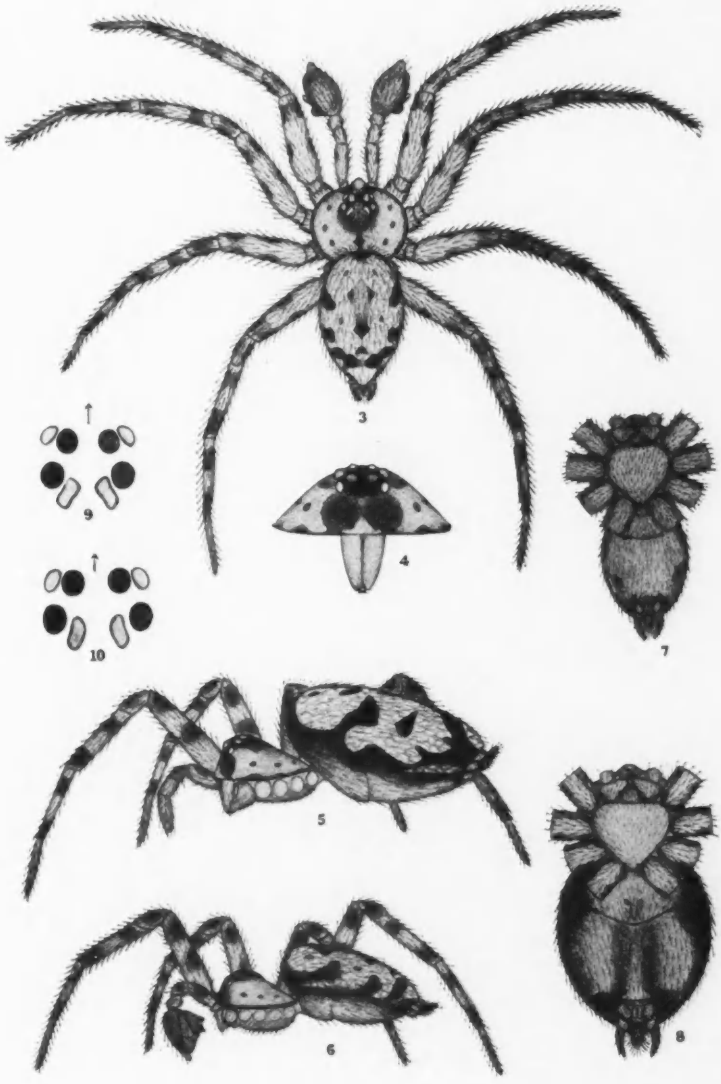
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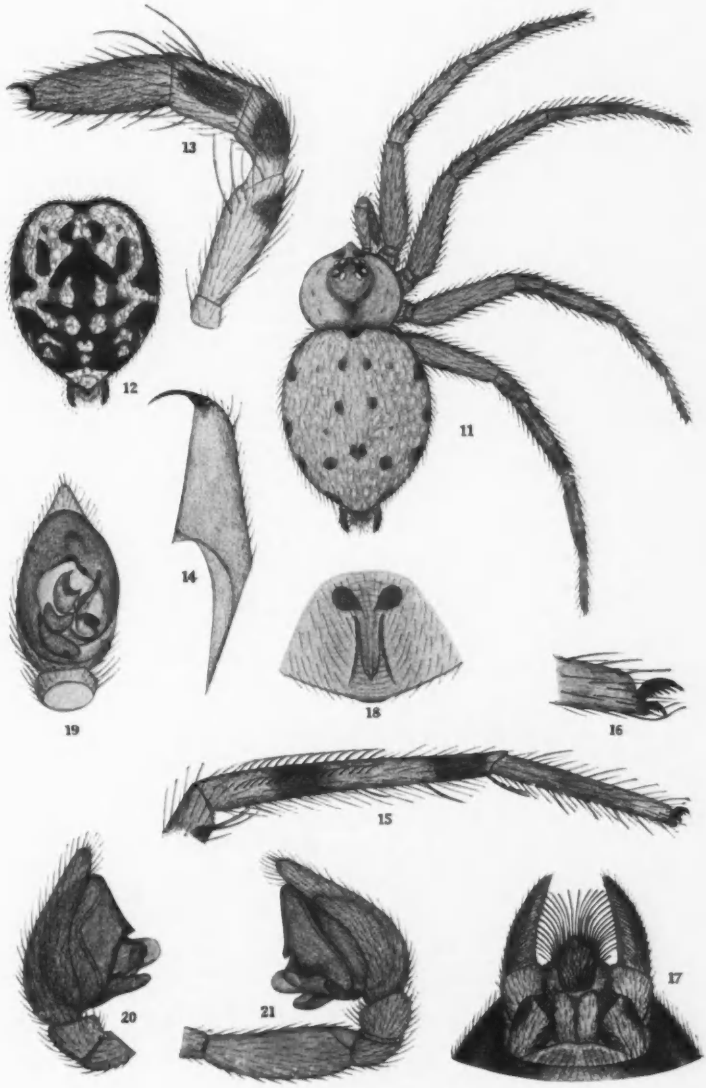
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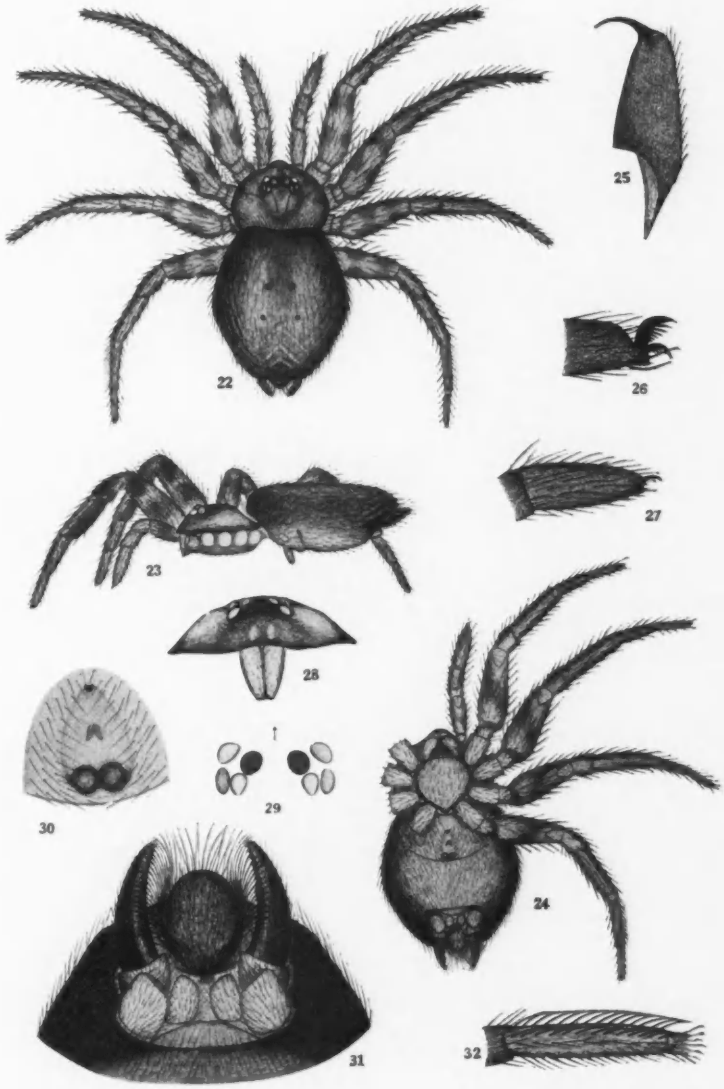
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FOUR WESTERN APHIDS[1]

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The following report deals with four apparently undescribed species of aphids, some of which are of economic importance. The writer is indebted to Professor M. A. Palmer, of the Colorado Agricultural Experiment Station, for her opinions concerning certain species dealt with in this report; one of the species is named in her honor.

Kakimia ribe-utahensis n. sp.

The summer ovipara, which constituted the major portion of the material collected upon native black currant at Cedar City, Utah, July 8, 1925, was somewhat of a surprise to the writer.

Alate vivipara.—Antennae (Fig. A, 1) 2.3 mm. long; antennal III, 0.6 mm. long, with about 38 sensoria; IV, 0.37, without sensoria; V, 0.34; VI, 0.1 + 0.64 mm.; rostrum reaching third coxae; rostral IV + V, 0.16 mm. long; hind tibiae, 1.47 mm.; tarsi, 0.11; cornicles, 0.39, imbricated, with flange, concolorous with body to slightly dusky; cauda pale, with two or three curved hairs on each side; hairs on body and appendages prominent, averaging about 0.03 mm. long and flattened at tip.

Apterous vivipara.—Size 2.4 mm. long and 1.34 mm. wide; antennal III, 0.7 mm., with 12 sensoria; IV, 0.35; V, 0.41; VI, 0.11 + (? broken); hind tibiae, 1.47; hind tarsi 0.1; cornicles, 0.44, pale.

Apterous ovipara.—Size 1.5 mm. long and 0.86 mm. wide; antennae, 0.9 mm.; antennal III, 0.16 to 0.18 mm.; IV, 0.09 to 0.1; V, 0.13 to 0.14; VI, 0.07 + 0.26 to 0.28; hind tibiae swollen, with about 50 sensoria, 0.52 mm. long; hind tarsi 0.09; cornicles, 0.16, pale; cauda with two lateral hairs on each side; anal plate broad, rather flat across the end; abdomen usually contains two eggs.

Kakimia ribe-utahensis runs to *K. cerei* G. and P. in Gillette and Palmer's key (Ann. Ent. Soc. Amer. 27: 160), from which it differs in having a shorter rostrum and rostral IV + V. It differs from *M. cynosbati* (Oest.) in having longer cornicles and longer rostrum in the alate.

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[1]Contribution from the Department of Entomology, Utah Agricultural Experiment Station. Authorized for publication by Director, February 16, 1935.

Macrosiphum harpagorubus n. sp.

Several slides of this aphid, collected upon blackberry at Puyallup, Washington, May 25, 1933, by A. J. Hanson, were received for identification. Most of the specimens were nymphs. The mature aptera did not appear to fit into any described species.

Apterous vivipara.—(Fig. A, 11, 12). Size 2.7 mm. long and 1.38 mm. wide; antennae, 2.88 mm. long; antennal III, 0.81 mm. with 2 to 3 sensoria; IV, 0.49; V, 0.45; VI, 0.17 + 0.7 mm.; rostrum short, reaching second coxae; rostral IV + V, 0.12 mm. long and at least half as broad; hind tibiae, 1.7 mm.; hind tarsi, 0.16; cornicles (Fig. A, 12), 0.88 mm.

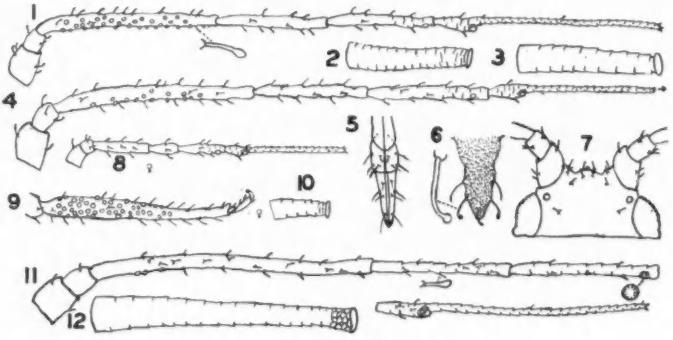

Fig. A

Kakimia ribe-utahensis n. sp. Alate, Nos. 1, 3, 7; apterous, Nos. 2, 4–6; ovipara, Nos. 8–10.

Macrosiphum harpagorubus n. sp. Apterous, Nos. 11–12.

long, with apex dusky; pale with about four rows of apical reticulations; cauda pale to dusky, with about three curved hairs on each side. *Nymphs* large, broad, having tendency to a lighter stripe down middle of the back.

Macrosiphum harpagorubus appears to be near *M. rosae* (L.) but differs in having a shorter distance at apex of cornicles covered by reticulations and fewer sensoria on antennal III of aptera.

Capitophorus palmerae n. sp.

Apterous vivipara.—Color green; size 2.36 to 2.93 mm. long to end of anal plate and 0.95 to 1.17 mm. wide; vertex of head (Fig. B, 1) convex with funnel-shaped hairs 0.04 to 0.048 mm. long; ocular tubercles lacking; antennae 3.75 mm. long, dusky to darker beyond middle of III, hairs sparse, short, blunt to enlarged at tip; antennal III, 0.73 to 0.91 mm. long with 2 to 6 (usually 2 to 3) rounded sensoria; IV, 0.65 to 0.75; V, 0.62 to 0.73; VI, 0.16 + 0.90 to 0.17 + 1.12 mm. long; rostrum reaches middle of second coxae, rostral IV + V, 0.11 to 0.13 mm. long; hind tibiae black at tip, 1.38 to 1.47 mm.; hind tarsi, 0.15 to 0.16 mm.;

abdomen armed with numerous funnel-shaped to fan-shaped hairs, as on rest of body; cornicles (Fig. B, 3) 0.52 to 0.65 mm. long, imbricated throughout, slightly enlarged for about 0.06 to 0.07 mm. preceding oblique flange, apex sometimes dusky; anal plate rounded to sometimes slightly pointed.

Capitophorus palmerae differs from *C. elongatus* Knowlton in having more numerous hairs on abdomen, a more rounded anal plate, longer rostral IV + V, longer hairs on vertex, and a tendency to more sensoria on antennal III of aptera. It differs from *C. longinectarius* Gillette and Palmer in having rostral tip acute but not needlelike, less conspicuous hairs on antennal I and II, and shorter cornicles. In shape, the cornicles of all three resemble those of *Macrosiphum packi* Knowlton, from which all differ in having funnel-shaped instead of pointed hairs on vertex.

Collected upon *Chrysothamnus nauseosus* at Tahoe National Forest, California, June 17, 1934 (Knowlton).

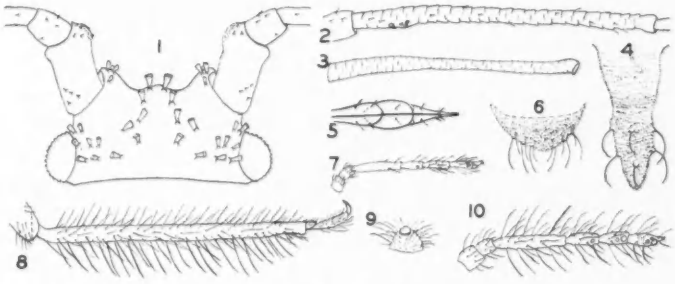

Fig. B

Capitophorus palmerae n. sp. Apterous, Nos. 1–6.
Cinara idahoensis n. sp. Alate, Nos. 7–9; apterous, No. 10.

Capitophorus elongatus Knowlton

Tip of rostrum acute but not needlelike; antennae of aptera 4.21 mm. long; antennal III, 0.19 + 1.12 to 0.20 + 1.19 mm. long; hind tibiae, 1.48; hind tarsi, 0.15 mm.

There seem to be two phases, some being lighter than others, the paler forms being most typical. On *Chrysothamnus viscidiflorus* at Emery, Sawtooth, and Nioche, July 28, 1928; *Chrysothamnus* at Black Ridge in Beaver County, May 2, 1934; *C. nauseosus* at Cedar Fort, August 22, 1932; *C. parryi* at Fountain Green, July 26, 1927, Utah.

Cinara idahoensis n. sp.

A bottle containing a few living and numerous dead and moldy aphids, together with a twig of evergreen that appeared

to be arborvitae, was received from Dr. J. C. Chamberlin, then of Twin Falls, Idaho. The material represented a species unknown to the writer. It is just possible that this may later prove to be an introduced European species; in the present state of our knowledge, however, it seems best to describe the species as new.

Alate vivipara.—(Fig. B, 7–9). Size small; eyes with ocular tubercles present; antennae 0.22 mm. long and dusky except proximal ends of III and IV; antennal III, 0.23 mm. long, without sensoria; IV, 0.11 mm. with one sensorium; V, 0.13 mm. with one secondary sensorium plus the primary; VI, 0.13 + 0.02 mm. long, with at least one secondary or marginal sensorium basad to the primary sensorium; rostrum nearly as long as body; rostral IV + V, 0.21 mm. long, acute; wings with media evanescent; legs with numerous long hairs; hind tibiae, 1.3 mm. long, armed with hairs about twice as long as thickness of segment; hairs 0.13 to 0.19 mm. long and many arise at an angle of about 45°; cornicles on dusky mamiform bases 0.17 mm. across; cauda and anal plate blackish, broadly rounded.

Apterous vivipara.—Antennae (Fig. B, 10) 0.85 mm. long with proximal portions of III and IV pale, balance dusky to black beyond middle of V; antennal III, 0.29 mm.; IV, 0.13, with one sensorium; V, 0.14 with one secondary besides the larger primary sensorium; VI, 0.16 + 0.02, with 3 to 4 secondary or marginal sensoria, located basad of primary and balance of marginal sensoria; rostral IV + V, 0.24 mm.; hind tibiae, 1.03 mm. with tibial hairs 0.16 to 0.21 mm. long; hind tarsi, 0.24 mm.; cornicles dusky to black, 0.16 to 0.23 mm. across the base.

In Gillette and Palmer's key (Ann. Ent. Soc. Amer., 24: 844–845) this species runs to *C. occidentalis* (Davidson) from which it differs in possessing fewer sensoria in alate and more in aptera.

Types in the collection of the writer; *Paratypes* of *Capitophorus palmerae* are at the U. S. National Museum, Colorado Agricultural Experiment Station, and in the collection of Dr. E. O. Essig.

A NEW "NOMENCLATOR ZOOLOGICUS"

The Zoological Society of London announces the preparation of a new "Nomenclator Zoologicus" which will cover the literature from the 10th edition of Linnaeus up to and including the literature for 1935. This will probably involve 190,000 names that have been used for genera, subgenera and higher groups. The Society wishes that all systematists report any names of genera or subgenera (with a reference to the original place of publication) that appear to have been omitted from existing records or catalogues. Send such references to Dr. S. A. Neave, O. B. E., F. Z. S., Imperial Institute of Entomology, 41, Queens Gate, London, S. W. 7, England.

BEE-FAUNA AND VEGETATION OF WISCONSIN

S. GRAENICHER,
South Miami, Florida

Much of the information presented in this article was obtained at Milwaukee, Wis., around the beginning and in the early part of the present century. In the meanwhile Milwaukee, the largest city of the state, has grown far beyond its former limits, thereby bringing about considerable changes in the biota of the surrounding territory. This statement applies especially to the various plant communities with which the bees were associated. In other words, this article deals to quite an extent with conditions as they were found years ago.

From Milwaukee collecting trips were made to many points in the eastern half of the state. In 1909, 1910 and 1911 the writer took part in three collecting expeditions of the Public Museum of Milwaukee along the western border of Wisconsin from the headwaters of the St. Croix River in the northwestern corner of the state south along the St. Croix and Mississippi Rivers to the southwestern corner at Rutledge, Grant County (opposite Dubuque, Iowa).

Material collected by members of the staff of the Public Museum of Milwaukee and others interested in the natural history of the state added in a most helpful way to the desired information.

A. THE CLIMATE OF WISCONSIN

A bulletin by Whitson and Baker (43) covers the subject in great detail. Between the southern boundary of the state and its most northern point there is a difference in latitude of about 40 degrees. A rise of the land from the southern part of the state to the watershed between the Brule and the St. Croix Rivers brings the altitude up to about 1000 ft. above sea level. From this point in the northwest corner of the state (Douglas Co.) an additional increase in altitude in an easterly direction reaches the highest point of the state (1800 ft.) in its northeast corner (Iron Co.). These so-called "Northern Highlands" show plainly the modifying influence of a large body of water to the north (Lake Superior), and one to the east (Lake Michigan); the summers are cooler and the winters less severe than they would be otherwise. The three factors combined, viz. the more northern latitude, the higher altitude and the proximity of large bodies of water on two sides, are responsible for the lowered mean temperature of that

section which forms a southern extension of the boreal region into Wisconsin as it is represented on the life zone map of the U. S. Biological Survey (22). In sharp contrast with these Northern Highlands is the Mississippi Valley along the western border of the state, with its deep depression between high bluffs. This, the warmest part of the state, has been referred to as a highway along which southern biotic elements have extended their range northward to a remarkable extent. On the eastern side of the state the prevailing east winds blowing across the cool waters of Lake Michigan favor the occurrence of boreal elements along the shore region as far south as the northeastern corner of Illinois.

B. THE MILWAUKEE REGION

The broad valley of the Menomonee River west of the city, with its moist grounds in lower situations, some terrace formations and its mostly wooded slopes, offered some of the most promising collecting grounds throughout the season. Deciduous forests of the basswood-maple-beech climax association, which is the dominant type of deciduous forest of the northeastern U. S., and the adjoining parts of Canada, are well represented. The dense shade of these forests favors the occurrence of numerous shade-loving shrubs and herbs, the flowers of which are attractive to bees. Plant communities of a more xerophytic type with oaks, shellbark hickory, black cherry among the trees, hazelnut, witchhazel, blackberries, some species of Viburnum among the shrubs, are scattered throughout the region. The flowers of some of the latter, as also of many herbaceous plants of the undergrowth, especially *Compositae*, are freely visited by bees.

In the southeastern part of the region a sandy stretch of land furnished a number of species of bees not met with in other less xerophytic areas.

The high clay bluffs bordering on Lake Michigan are of especial importance. Between the foot of the bluffs and the lower beach there is mostly a strip of sandy shore of varying width where some of the characteristic plants of the middle and upper beach occur. On the upper beach *Lathyrus maritimus*[1], *Potentilla Anserina* and *Salix longifolia* are visited by bees, as also *Rhus typhina* on higher ground. On the slopes of the clay bluffs farther north, at Whitefish Bay and beyond, the following plants are found: *Parnassia caroliniana*, *Tofieldia glutinosa*, *Shepardia canadensis* and *Lilium philadelphicum* var. *andinum*. These are boreal species, the existence of which in this latitude is due to the cooling influence of the lake.

The earliest entomophilous plant of the region is *Trillium nivale*, the smallest of the *Trilliums*. Its flowers opened as early as March 26 in 1898, and as late as April 11 in 1899. No visitors were seen at the flowers. Several days later (March 29, 1898) *Erigenia bulbosa*, the earliest of the *Umbelliferae*, appeared in blossom, and on April 12 the females of 2 species of short-tongued bees, *Halictus lerouxii* Lep. and *H. pilosus* Sm., were noted as visitors.

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[1]Classification and nomenclature according to Gray's Manual of Botany, 7th edition, 1908.

The appearance of the first willow catkins in bloom brings a decided upswing in the activity of the flower-visiting insects of the region. In our earliest willow, *Salix discolor*, the pistillate catkins begin to bloom about 2 days ahead of the staminate ones, the latter with a rich supply of yellow pollen and nectar. At this time of the year the willows, as well as other shrubs and trees of their surroundings, are still leafless, and for this reason the very conspicuous yellow staminate catkins are plainly visible from a distance.

To what extent the date of appearance of the first staminate blossoms of *Salix discolor* differs from year to year may be seen from the following: April 22, 1900; April 29, 1901; March 31, 1903; April 27, 1906.

In addition to several kinds of introduced exotic willows there are at least 10 indigenous species in the Milwaukee flora, the blossoms of which are of much importance to the bee-fauna of the earlier months, especially to the short-tongued bees of the genera *Andrena* and *Halictus*.

A group of *Salix discolor*, the earliest of our willows, was kept under observation in the exceptionally early spring of 1903. With the appearance of their first staminate catkins on March 31 both sexes of *Andrena cockerelli* Graen., our earliest species of *Andrena*, were taken as visitors. *Osmia lignaria* Say, a male, was the only other bee at the flowers on this date. Following the willow blossoms there is a gradual increase in the number of flowers belonging to other families, as also a corresponding increase in species of bees.

With the opening of the flowers of *Antennaria neglecta* around the end of April the *Compositae*, the largest and in some respects most important family of entomophilous flowers is ushered in. Russel's list of the flora of Milwaukee Co. (29) gives 921 species, 628 of which are considered by the writer to be entomophilous. The *Compositae* are represented with 152 species, or 24.2% of the entomophilous flora. The close grouping of the small flowers (florets) in an inflorescence (known as a "head" or capitulum) so characteristic of the family offers unusual facilities to insects in search of nectar or pollen or both. Flowers occurring in inflorescences of a similar type, in which the individual flowers are brought into close contact, have been termed "social flowers." The *Umbelliferae* and the *Compositae* furnish well-known examples. While the individual flowers of the *Umbelliferae* are of a simple type with exposed or at least only partly concealed nectar, those of the *Compositae* consist mostly of tubular florets with nectar at the bottom of tubes varying in length in the various species. For these reasons the *Umbelliferae* attract mainly insects of a lower type, and, so far as bees are concerned short-tongued species. The *Compositae*, on the other hand, while very attractive to the most specialized among the Diptera (species of *Bombyliidae*, *Syrphidae* and *Conopidae*), show plainly their outstanding importance in the economy of the bees. The extent to which the *Compositae* are represented in both hemispheres leads to the conclusion that the family has reached a favored position among the families with entomophilous flowers. Various writers have emphasized the importance of this inflorescence, and Lovell (20) has referred to it as "Nature's greatest triumph in flower building."

Andrena Fabricius

In a paper on the relations of the *Andrenine* bees to the flora of Milwaukee Co. (11) the writer listed the species, giving the period of flight for each so far as known. Additional information gathered since calls for slight corrections. There is a total of 47 species; an *early group* comprising 35 of the species starts with *A. cockerelli* Graen. around the beginning or the middle of April, reaches a maximum in the latter part of May when 24 species are on the wing, with a falling off in the number of species to a minimum of the early group lasting from about July 17 to 20, and represented by a single species. Starting around July 20, the *late group* of only 12 species reaches a maximum with 9 species in flight around the end of August and the beginning of September; a decrease in number during September and early October closes the season for the *Andrenine* bees.

One-third of the 35 species of the *early group* are obligotropes (now called oligoleges by Robertson), and are named herewith in the order of their appearance: 5 on the willows (*cockerelli* Graen., *illinoensis* Robt., *mariae* Robt., *erythrogastra* Ashm., *Parandrena andrenoides* Cress.); *erigeniae* Robt., an oligotrope of *Claytonia virginica; fragariana* Graen., an oligotrope of small-flowered *Rosaceae*, was originally considered an oligotrope of *Fragaria virginiana* only, but it collects pollen also from *Potentilla canadensis*, and Cockerell has seen it in Colorado on the flowers of a *Drymocallis* (the same as *Potentilla*). The *Umbelliferae* have 2 oligotropes (*ziziae* Robt. and *wheeleri* Graen.) and *Geranium maculatum* has 1 (*geranii maculati* Robt.).

The flowers of 2 species of *Compositae* appear around the end of April, of others in May and June and all of these are visited by species of the *early group* of *Andrena*. The species of the *late group* of *Andrena* are with a single exception oligotropes of *Compositae* that blossom after July 1. In other words, there is an early group of *Compositae* visited by species of the early group of *Andrena*, and a late group of *Compositae* comprising most of the species and forming a maximum for the family at the end of August, with which the maximum of the late group of *Andreninae* coincides. *Andrena parnassiae* Ckll., an oligotrope of *Parnassia caroliniana*, is the only member of this group not visiting the *Compositae*. The remaining 11 species, oligotropes of *Compositae*, have been taken on the following:

1. *A. peckhami* Ckll. on two species of *Solidago*, two of *Aster*, one of *Heliopsis*, one of *Rudbeckia*, one of *Helianthus*, one of *Cacalia*, one of *Cirsium*.
2. *A. chromotricha clypeonitens* Ckll. One of *Polymnia*, one of *Lepachys*.
3. *A. nubecula* Sm. Four of *Solidago*, three of *Aster*.
4. *A. aliciae* Robt. Two of *Helianthus*, one of *Heliopsis*.
5. *A. helianthi* Robt. Two of *Helianthus*, one of *Helenium*.
6. *A. hirticincta* Prov. (*americana* D. T.). One of *Eupatorium*, five of *Solidago*, nine of *Aster*.
7. *A. solidaginis* Robt. One of *Solidago*.
8. *A. asteris* Robt. Two of *Solidago*, four of *Aster*.
9. *A. rudbeckiae* Robt. One of *Rudbeckia*.
10. *A. persimilis* Graen. Three of *Solidago*.
11. *A. graenicheri* Ckll. One of Aster.

The names of all of the species of *Andrena*, as also of the other genera, will be found in the list of bees of Wisconsin, near the end of this article (G).

Halictus Latreille

While in *Andrena* both sexes appear together and there is one generation only in our region, the hibernating females of *Halictus* appear alone, ready to start their nests, from which later males and females forming the second generation emerge. Some of the females fly early, two of the species having been mentioned as visitors of *Erigenia bulbosa*. For the males the earliest date noted is June 23. There are at least two generations, and both sexes are found together on the flowers in late summer and fall. Oligotropic relations to flowers are the exception in the *Halictinae*, a single species, *Halictus nelumbonis* Robt., an oligotrope of the *Nymphaeaceae*, being known from Wisconsin. It has not been found in the Milwaukee region.

Colletes Latreille

All but 2 of the 9 species of the Milwaukee fauna are oligotropes. The sexes appear close together. *C. inaequalis* Say, the earliest of our species, visits the catkins of *Salix discolor* in April, but neither this, nor *C. eulophi* Robt., which flies from the end of June on, is oligotropic. In the order of their appearance the 7 oligotropes are as follows:

C. aestivalis Patt., an oligotrope of *Heuchera hispida* (Fam. *Saxifragaceae*), the flowering period of which extends from about June 3 to July 15.
C. latitarsis Robt. and *C. willistoni* Robt. are both oligotropes of *Physalis* (Fam. *Solanaceae*).
C. brachyceros Swk. is an oligotrope of the *Campanulaceae*. It visits *Specularia perfoliata* in Illinois (Robertson) and *Campanula rotundifolia* at Milwaukee.
C. armatus Patt., *C. americanus* Cress., and *C. compactus* Cress. are oligotropes of *Compositae*.

Hylaeus Fabricius (**Prosopis** Fabricius)

With the sparse pubescence on the surface of their bodies and lacking the pollen-collecting structures so typical of the average nesting bee, these insects, which are among the smallest of the bees, are comparable in structure and general appearance to some of the solitary predaceous wasps. The food of the larvae consists of a semi-liquid mixture of nectar and pollen. There are 7 species at Milwaukee.

Eunomia Cresson

E. heteropoda Say is the largest of our short-tongued bees, and flies in August. It is rarely met with, and no records of visits to flowers have been obtained.

Perdita Smith

Most of the species are oligotropic. Of the 6 known from Wisconsin and dealt with by the writer in a former paper (15), only 2 have been found at Milwaukee. *P. maura* Ckll., an oligotrope of *Physalis* (Fam. *Solanaceae*), flies from the middle of June to early August; for our second species *P. maculipennis* Graen., described from Milwaukee, the original host-plant has not been determined beyond a doubt.

Calliopsis Smith

C. andreniformis Sm., our only species, appears from the last week in June on, a male having been taken June 22, and a pair in copula June 27. Both sexes fly past the middle of September, and have been noted as visitors to some of the late *Compositae.*

Panurginus Nylander

P. rudbeckiae Robt. is, according to Robertson, an oligotrope of the *Compositae.* A single specimen, a male, has been taken on *Aster prenanthoides* Sept. 7.

Macropis Panzer

The species of this holarctic genus are oligotropes of genera of *Primulaceae,* in Europe of *Lysimachia,* and in this country of *Steironema. M. morsei* Robt., the only species of the Milwaukee region, collects pollen from *Steironema ciliata* and flies from about the last week in June to early August.

Anthophora Latreille

There are 4 species in the Milwaukee fauna, 1 of which, *A. walshii* Cress., is, according to Robertson, an oligotrope of *Cassia Chamaecrista* (Fam. *Leguminosae.*). A female was observed at the flowers of *Allium cernuum* July 27. One male of *A. abrupta* Say was taken on the flowers of *Lonicera Sullivantii* June 26, and another one on those of *Asclepias phytolaccoides* June 15. A male of *A. ursina* Cress., the third of our species, was captured on the flowers of *Pentstemon hirsutus* June 15.

The most common, and as a flower visitor most important, of our species is *A.* (*Clisodon*) *terminalis* Cress., which, as announced by Sladen, may be the *A. furcata* of Europe. It shows a preference for flowers of the *Labiatae.* It flies from about the middle of June to the middle of September.

Tetralonia Spinola

A single species, *T. robertsonii* Ckll., is an oligotrope of the *Leguminosae,* as stated by Robertson (27). The sexes appear together from May 20 on and the latest date of capture for a female was August 17. Visits noted to 4 species of *Leguminosae,* 1 of *Geraniaceae* and 1 of *Caprifoliaceae.*

Melissodes Latreille

A genus of 7 species at Milwaukee, the following 5 of which are oligotropes of *Compositae:*

M. agilis Cress. Has been taken on species of *Liatris, Grindelia, Solidago, Rudbeckia, Lepachys, Helianthus* and *Helenium.*

M. trinodis Robt. On species of *Liatris, Grindelia, Solidago, Aster, Heliopsis, Rudbeckia, Lepachys, Helianthus* and *Arctium.*

M. rustica Say. On species of *Eupatorium, Solidago, Aster* and *Helianthus.*

M. desponsa Sm. On species of *Aster, Helianthus, Arctium* and *Cirsium.* Robertson says it is an oligotrope of *Cirsium.*

M. coloradensis Cress. is also, according to Robertson, an oligotrope of species of *Compositae*. One male August 23.

The 2 remaining species are *M. obliqua* Say and *M. nivea* Robt. The bees of this genus fly late, both sexes having been found from the first week in July on. They come together with the late group of *Compositae*, and are among the more important visitors of the latter.

Megachile Latreille

These bees, known as "leaf-cutter bees," appear from the middle of June on, and the periods of flight of most of them coincide with the blooming of the late *Compositae*. There are 11 species in the Milwaukee region.

M. pugnata Say is an oligotrope of species of *Compositae*.

A second oligotrope, *M. campanulae* Robt., depends for pollen on *Campanula americana*.

Osmia Panzer

A male of *O. lignaria* Say was taken on the catkins of *Salix discolor* March 31, an exceptionally early date for members of this normally early genus, some of which appear a month or more later, others in June. None of the 7 species is oligotropic.

Monumetha Cresson

A single species, *M. albifrons* Cress. One male was taken May 29, and a female July 14.

Alcidamea Cresson

A. producta Cress., the only species of the region, flies from about May 19 to July 14, probably later.

Heriades Spinola

One species, *H. carinatus* Cress. Period of flight June 28–August 5.

Andronicus Cresson

A single species, *A. cylindricus*, flying in July.

Ceratina Latreille

Two species are known from Milwaukee, one of which, *C. dupla* Say, is fairly common at flowers. *C. calcarata* Robt. is easily recognized in the male, while for the female no distinct characters separating it from that of *dupla* have been found. Males of both species were taken in the last week of April on flowers of *Sanguinaria canadensis*, both sexes of *C. dupla* on willow blossoms May 5, and a female was flying as late as September 21.

Bombus Latreille

The bumble bees are characterized by a combination of factors offering them special advantages. Most of them surpass the other bees of our fauna in tongue length, and this gives them access to nectar entirely out of reach of shorter tongues. The strength of their large bodies enables them to pry open flowers of a closed type (such as the

snapdragons, species of *Antirrhinum*) that cannot be entered by smaller and weaker species. Still another advantage lies in the fact that as social bees they are represented in the summer and fall by workers in addition to the females and males, and this means a considerable increase in the number of individuals. Males and workers perish in the fall and the hibernating females appear in the spring ready to start new colonies. The first of the species to appear is *B. americanorum* Fab., our most common bumble bee, taken on the willows as early as April 17. The first individuals emerging from the nest are the workers, and later in the season males appear. For *B. americanorum* the earliest date for a worker was June 20, for a male August 2.

The females of 2 other species appear in April, 6 in May and the remaining 2 in June.

In the foregoing an account has been given of the relations to flowers of those bees, the nest-building females of which visit flowers in search of nectar, and of pollen, the latter forming the essential part of the food supply for their offspring. This dependence on pollen has led to the close relations between bees and flowers as we find them in the oligotropic bees.

The parasitic bees do not construct nests of their own, their visits to flowers are for the sole purpose of obtaining food for their individual needs; they do not collect pollen, their relations to flowers are not of the same importance as those of the nest-builders; for this reason they will be dealt with separately near the end of this article (F).

The names of the oligotropic species of Milwaukee Co. have been given, together with the flowers visited for pollen. The following families of plants are represented:

Compositae with 21 oligotropes.
Salicaceae with 5 oligotropes.
Solanaceae with 3 oligotropes.
Umbelliferae with 2 oligotropes.
Campanulaceae with 2 oligotropes.
Portulacaceae with 1 oligotrope.
Geraniaceae with 1 oligotrope.
Rosaceae with 1 oligotrope.
Parnassiaceae with 1 oligotrope.
Saxifragaceae with 1 oligotrope.
Primulaceae with 1 ologotrope.
Leguminosae with 2 oligotropes.

The Compositae, with 21 oligotropes, outnumber the other families with their total of 20 oligotropes. The advantageous position of the *Compositae* among the families of plants, as a result of their unique type of inflorescence, was emphasized in a previous part of this paragraph; the number of oligotropes adapted to flowers of this family is significant in this respect.

C. THE PRAIRIE NEAR CORLISS, RACINE COUNTY

As set forth by Pound and Clements (26), the Prairie Province ranges from its center in the great plains of the West southward into Texas, northward along the Rocky Mountains into several of the southern provinces of Canada, and, besides, it sends an eastern extension through southern Minnesota and Iowa into southern Wisconsin, northern Illinois and western Indiana.

In an article on the characteristic plants of a typical prairie in Clay Co., Kansas, a region in the center of the Prairie Province, Schaffner (31) described the following conditions. Listed in the order of their importance, the typical grasses were *Andropogon furcatus* (big blue-

stem), *A. scoparius* (little blue-stem), *Sorghastrum nutans* (Indian grass,), and *Panicum virgatum*. All of these are large grasses, the big blue-stem reaching under the most favorable conditions a height of 11 ft.

The small-sized prairie grasses were *Bouteloua curtipendula*, *B. oligostachya* (smooth mesquite grass), *B. hirsuta* (hairy mesquite grass), and *Buchloë dactyloides* (buffalo grass).

The above represent the more characteristic species among the grasses and most of them are found on the prairie near Corliss, Racine Co. Many of the typical flowering plants attractive to bees occur there, as, for example, *Amorpha fruticosa*, *Baptisia bracteata*, *B. leucantha*, *Petalostemum candidum*, *P. purpureum*, *Lespedeza capitata*, *Viola pedatifida*, *Oxalis violacea*, *Physalis virginiana* and *Cassia Chamaecrista*.

To the summer group of *Compositae* belong some of the especially characteristic and conspicuous elements of the prairie flora, such as several species of goldenrods, *Aster sericeus*, *Liatris scariosa*, *L. spicata*, *Silphium integrifolium*, *S. laciniatum*, *Helianthus occidentalis*, *H. strumosus*, *Coreopsis palmata* and *Grindelia squarrosa*.

This prairie in Racine Co. was still in a normal condition on the writer's first visit in the spring of 1897, later on it was gradually drained and made fit for agricultural purposes.

A railroad connecting Racine with Corliss runs through the prairie where the latter is low and mostly wet; there are floral elements of a "wet prairie" on the low grounds and a "dry prairie" on the higher grounds.

Although the remnants of the prairies in this part of Wisconsin are situated on the outskirts of the Prairie Province, this particular one near Corliss contains a large percentage of the characteristic plants, and Wadmond (42) referred to it as a "typical bit of prairie flora reminding one of an Iowan prairie."

What has just been stated for the flora does not hold good for the bee-fauna; flowers that elsewhere were usually well attended showed an astonishing lack of visitors. The occurrence of a bee in a given locality depends not only on the presence of suitable flowers; conditions of the medium in which they place their nests (soil, dry stems, under bark, etc.) are of the greatest importance. For *Tetralonia frater* Cress. this prairie furnished the only record for the state. *Agapostemon texanus* Cress. was taken here as also in the Kenosha–Waukegan dune area, a description of which follows.

D. SAND DUNES ALONG THE WESTERN SHORE OF LAKE MICHIGAN

Nowhere along the western shore of Lake Michigan are dunes to be found of such dimensions, and presenting such a wealth of ecological problems as those along the eastern shore, a most detailed account of which has been furnished by Cowles. There are, however, two good-sized dune areas on the western shore of Lake Michigan differing considerably in the composition of their biota. One of them begins south of Kenosha in the southeast corner of Wisconsin and reaches into the northeastern corner of Illinois north of Waukegan. About 120 miles north of this is the dune area of Two Rivers, Manitowoc Co., Wis.

1. The Kenosha–Waukegan Dune Area

Beach, a station on the Milwaukee-Chicago division of the Chicago & Northwestern R. R. about 3 miles north of Waukegan, lies west of the best developed portion of these dunes. Seen from a distance pines and oaks are the most conspicuous elements of the vegetation. Oaks are represented by 5 species (red, scarlet, black, white and bur oak) and there are also some poplars (cottonwoods and aspens) intermixed with the other trees. The pines and oaks with their undergrowth of shrubs and herbs are mostly on the higher grounds of the sand plain at some distance from the beach and ridge formations along the lake. On the upper beach *Lithospermum canescens* and *Oenothera biennis* occur together with *Euphorbia polygonifolia*, *Salsola* Kali var. *tenuifolium*, *Xanthium strumarium* and *Corispermum hyssopifolium*. Adjoining the upper beach is a narrow belt of low dunes with *Prunus pumila* and *Salix syrticola*, and to the west of these a group of pines. Between and beyond the pines heaths occur with the following plants: *Juniperus horizontalis*, *Arctostaphylos Uva-ursi*, *Euphorbia corollata*, *Potentilla fruticosa*, *Artemisia canadensis* and *Rosa blanda*. Where the pines become less frequent a cactus, *Opuntia humifusa*, and *Ceanothus ovatus* are found, and still farther west the oaks and cottonwoods are larger and more frequent.

Near the end of April the catkins of *Salix discolor* were visited by both sexes of *Parandrena andrenoides* Cress., an oligotrope of the willows. During the first week of May flowers of *Antennaria neodioica*, *A. plantaginifolia*, *Arctostaphylos Uva-ursi* and *Pedicularis canadensis* may be expected. On the willows males of the bee *Colletes inaequalis* Say were taken May 4, and on May 7 *Andrena erythrogastra* Ashm., *A. nivalis* Sm., *Halictus lerouxii* Lep., *H. provancheri* D. T., *H. pilosus* Sm., *Agapostemon radiatus* Say, *Ceratina dupla* Say, *Sphecodes arvensis* Patt., *Bombus impatiens* Harr., *B. terricola* Kby., and *B. vagans* Cress. *B. americanorum* Fabr. was at the flowers of *Lithospermum gmelini* June 11, and *Aleidamea producta* Cress. was on *Iris versicolor*.

On June 18 *Bombus separatus* Cress. was visiting the flowers of *Acerates viridiflora*, *B. fervidus* Fabr. those of *Lithospermum gmelini*. The following *Compositae* were open on that date: *Rudbeckia hirta*, *Krigia amplexicaulis*, *Erigeron annuus*, *Senecio Balsamitae* and *Coreopsis lanceolata* var. *villosa*. Visiting *Rudbeckia hirta* were *Halictoides marginatus* Cress. and *Halictus vierecki* Crawf.

On July 2 *Monarda punctata*, *Oenothera rhombipetala*, *Asclepias tuberosa*, *Verbena stricta*, *Amorpha canescens*, *Euphorbia corollata*, and *Opuntia humifusa* were in bloom, all of them species of the western plains. Later on some additional characteristic flowering plants of the western plains and arid regions of the southwest (austral elements) made their appearance, such as *Petalostemum violaceum*, *Astragalus neglectus*, *Lespedeza capitata*, *Helianthus occidentalis*, *H. strumosus*, *Liatris scariosa*, *Solidago ohioensis*, and the grasses *Andropogon furcatus*, *A. scoparius*, *Panicum virgatum* and *Koeleria cristata*.

By far the greater part of the biota of this area is composed of elements of the upper austral zone, and these occupy the more western portion remote from the lake. The vicinity of the lake, on the other

hand, with its beaches, ridges and other sandy stretches exposed to the influences of the large body of water and the prevailing lake winds is inhabited by typical elements of the boreal zone.

2. Dunes at Two Rivers

This dune area lies north of the city of Two Rivers in Manitowoc Co., Wis. Two creeks enter Lake Michigan from the west. The dominant trees are conifers of the northern forests: hemlock, arbor vitae, red and white pine, and, in some places, the tamarack. The deciduous trees of importance are poplars, mainly those of northern distribution: the balsam poplar and the large-toothed aspen. The shrubbery and herbaceous vegetation are made up for the greater part of northern elements.

The following conditions were found in late summer months. Near the southern end of the dunes 3 distinct ridges running parallel to the lake support a vegetation changing from ridge to ridge, and the following species were noted: *Salix discolor, S. glaucophylla, S. syrticola, Populus balsamifera* of a small size, *Lathyrus maritimus, Cornus stolonifera, Cnicus Pitcheri, Rosa blanda, Pedicularis lanceolata, Tofieldia glutinosa, Mitchella repens, Linnaea borealis, Pyrola asarifolia* and *P. chlorantha.*

In open places heaths occur with *Arctostaphylos Uva-ursi, Juniperus communis* var. *depressa, Prunus pumila, Oenothera biennis, Smilacina stellata, Arabis lyrata, Campanula rotundifolia, Arenaria stricta* and *Solidago nemoralis.*

Farther north are some active dunes, west of which between pines and birches a heath with *Liatris scariosa, Diervilla Lonicera, Monarda fistulosa, Anemone cylindrica* and several red oaks occurs.

A number of late-blooming *Compositae* were noted, but none of the species of *Andrena* which are oligotropes of the late *Compositae* were present except *A. hirticincta* Prov., neither was *Andrena parnassiae* Ckll., although its host-plant *Parnassia caroliniana* was in full bloom.

The vernal flora appears later than in the Kenosha-Waukegan region. At the end of June *Rosa blanda* was visited by *Bombus borealis* Kby., *Hylaeus basalis* Sm., *Andrena nivalis* Sm., *A. placida* Sm., *Megachile wootoni* Ckll., *M. vidua* Sm. and *M. infragilis* Cress.; *Campanula rotundifolia* by its oligotrope *Colletes brachyceros* Swk. and *Coelioxys ribis* Ckl.; *Rudbeckia hirta* by *Megachile brevis* Say.

3. A Comparison of the Biota of the Two Dune Areas

The oaks of the Kenosha-Waukegan flora are characteristic austral elements, while the trees of the Two Rivers dunes, being mostly species of the northern group of conifers, are characteristic of the boreal region.

The following flowering plants of the Kenosha-Waukegan dunes have not been found by the writer on the Two Rivers dunes: *Astragalus neglectus, Amorpha canescens, Petalostemum violaceum, P. candidum, Baptisia leucantha, Lupinus perennis, Lespedeza capitata, Euphorbia corollata, Opuntia humifusa, Asclepias tuberosa, Lithospermum canescens,*

Verbena hastata, V. stricta, Monarda punctata, Physalis virginiana, Gerardia grandiflora, G. purpurea, Solidago rigida, S. speciosa, S. ohioensis, Silphium integrifolium, Helianthus occidentalis, Helenium autumnale, Senecio Balsamitae.

Most of these are typical plants of the prairie region.

Bees from this area not taken in the Two Rivers dune area are as follows: *Bombus americanorum* Fabr., *B. impatiens* Harr., *Melissodes obliqua* Say, *M. trinodis* Robt., *Dianthidium simile* Cress., *Megachile pruina* Sm., *Perdita bruneri* Ckll., *P. lacteipennis* Swk. & Ckll., *P. gerhardi* Vier., *Halictoides marginatus* Cress., *Andrena erythrogastra* Ashm., *A. fragilis* Sm., *A. nasoni* Robt., *Colletes inaequalis* Say., *C. compactus* Cress., *C. productus* Robt., *C. armatus* Robt., *Halictus vierecki* Crawf., *H. graenicheri* Ellis, *H. ligatus* Say, *Agapostemon texanus* Cress.

Of these the following are oligotropes: Six of *Compositae* (*Melissodes trinodis, Perdita bruneri, P. lacteipennis, Halictoides marginatus, Colletes compactus, C. armatus*), one oligotrope of *Monarda punctata* (*Perdita gerhardi*), and one oligotrope of *Salix* (*Andrena erythrogastra*).

Plants of northern distribution from the Two Rivers dune area not found by the writer in the Kenosha-Waukegan dune area are: *Clintonia borealis, Maianthemum canadense, Acer spicatum, Shepardia canadensis, Cornus canadensis, Pyrola chlorantha, P. asarifolia, Melanpyrum lineare, Galium boreale, G. trifidum, G. triflorum, Mitchella repens, Linnaea borealis, Lonicera hirsuta, Campanula rotundifolia, C. aparinoides, Cirsium Pitcheri.*

Bees of northern distribution found in the Two Rivers area but not in the Kenosha-Waukegan dune area are: *Bombus vagans* Cress., *B. ternarius* Say, *Megachile vidua* Sm., *M. wootoni* Ckll., *Coelioxys ribis* Ckll., *Andrena wheeleri* Graen., *Hylaeus basalis* Kby., *Halictus versans* Lov., *Sphecodes davisii* Robt.

The only oligotropic species among them is *Andrena wheeleri*, an oligotrope of the *Umbelliferae.*

The vegetation of the beach is much the same in both areas, as also that of the sandy ridges and heaths, all of which show plainly the influence of the lake in favoring the southward range of boreal elements. Such plants are *Tofieldia glutinosa, Lilium philadelphicum* var. *andinum, Betula papyrifera, Salsola Kali* var. *tenuifolia, Corispermum hyssopifolium, Arabis lyrata, Cakile edentula, Prunus pumila, Potentilla Anserina, Euphorbia polygonifolia, Shepardia canadensis, Arctostaphylos Uva-ursi, Equisetum hyemale, Juniperus horizontalis, J. communis* var. *depressa* and *Juncus balticus* var. *littoralis.*

Two bees of northern distribution which are common on the dunes at Two Rivers extend their range into the Kenosha-Waukegan dune area: *Andrena nivalis* Sm. and *Bombus borealis* Kby. (record by Frison).

The two dune areas considered above are the most extensive and most characteristic of the dune areas known to the writer to occur along the western shore of Lake Michigan. The vegetation of the sand dunes of Washington Island, north of the tip of Door Co., Wis., an account of which has been given by A. M. Fuller (10), is much the same as that of the Two Rivers dune area.

E. THE WESTERN BORDER OF WISCONSIN

In an article on the "Bees of Northwestern Wisconsin" (14), the writer presented a list of bees, together with some biological information obtained on 2 collecting expeditions of the Public Museum of Milwaukee in 1909 and 1910 along the St. Croix River and Mississippi River as far as Fountain City, Buffalo Co. A third expedition in 1911 covered the remaining stretch along the Mississippi River from Genoa, Vernon Co. to Rutledge, Grant Co. in the southwestern corner of the state.

1. The Boreal Region in Northwestern Wisconsin

On July 7, 1909 the first camp was established north of Solon Springs, Douglas Co., at the northern end of the Upper St. Croix Lake, Douglas Co., a short distance south of the watershed between the Brule and the St. Croix Rivers. This locality is in the "Northern Highlands" of Wisconsin.

The dominant trees are the white, red and jack pine, three characteristic elements of the eastern type of the northern transcontinental coniferous forest belt. The jack pine, being the most xerophytic of the three, grows in the poorest soils, the red pine is less xerophytic, and the white pine as the least xerophytic favors more fertile soils. The sphagnum bogs so characteristic of this region contain, as usual, a rich assemblage of northern shrubs and herbs. In addition to the pines the following typical arboreal elements of the northern woods were found: balsam fir, arbor vitae and balsam poplar; 2 species of alder (*Alnus rugosa* and *A. incana*) were there, as also *Nemopanthus mucronata*, a species of rare occurrence. Among the flowering plants may be mentioned *Lilium philadelphicum* var. *andinum*, *Clintonia borealis*, *Maianthemum canadense*, *Cornus canadensis*, *Lonicera hirsuta*, *Galium boreale*, *Trientalis americana*, *Pyrola asarifolia*, *Mitchella repens* and *Linnaea borealis*. All of these show plainly the boreal character of the vegetation.

At Solon Springs the representative species of bumblebees were *Bombus ternarius* Say, *B. vagans* Cress., *B. terricola* Kby., together with the parasitic *Psithyrus ashtoni* Cress. *Bombus borealis* Kby., a typical northern species, was taken at Gordon, also in Douglas Co. *Anthophora bomboides* visiting the flowers of *Apocynum androsaemifolium* furnished the only record of this species for the state.

The following species described as new were taken at Solon Springs: *Colletes vicinalis* Graen., *Sphecodes solonis* Graen. and *Andrena nivaloides* Graen.; the type of *Halictus nigro-viridis* Graen. is from Swiss, Burnett Co., in the boreal zone.

2. The Transition and Upper Austral Zones of Western Wisconsin

On the life zone map of the U. S. Biological Survey (22) the border line between the boreal and transition zones crosses the St. Croix River in the region where the Yellow River, a tributary of the St. Croix, joins the latter (about 46′ latitude). The majority of the bees

collected along the St. Croix and Mississippi Rivers are of southern or western distribution; while some of the latter enter the adjoining boreal region most of them have not been found north of the mouth of the Yellow River in Burnett Co. The time of the year in which the collections were made brings them in contact with late-blooming species of *Compositae* and of several other families upon which they depend for pollen.

Among the more common western plants found from the mouth of the Yellow River on south to the southern border of Wisconsin in Grant Co. are the following species:

Fam. *Compositae: Helianthus occidentalis, H. scaberrimus, Coreopsis palmata, Helenium autumnale, Heliopsis scabra, Krigia amplexicaulis, Lepachys pinnata, Rudbeckia laciniata, Grindelia squarrosa, Silphium laciniatum, S. integrifolium, S. perfoliatum, Aster sericens, Liatris scariosa, Vernonia fasciculata,* and several species of *Solidago.*

Fam. *Verbenaceae: Verbena hastata* and *V. stricta.*

Fam. *Solanaceae: Physalis heterophylla* and *P. virginiana.*

Fam. *Boraginaceae: Lithospermum gmelini.*

Fam. *Onagraceae: Oenothera biennis, O. rhombipetala.*

Fam. *Leguminosae: Baptisia leucantha, B. bracteata, Lespedeza capitata, Lupinus perennis, Amorpha canescens, Petalostemum candidum, P. violaceum,* and *P. villosum.* The characteristic prairie grasses *Andropogon furcatus, A. scoparius, Sorghastrum nutans, Panicum virgatum, Bouteloua hirsuta* and *B. curtipendula* are also represented.

In the summer of 1911 collecting was carried on in the "Driftless Area" from Genoa, Vernon Co. (south of La Crosse) to Rutledge in the southwestern corner of Wisconsin. This area has never been covered by the ice of the glacial epochs, and the high bluffs along the Mississippi valley present the physiography of a region exposed to erosion over a period of considerable length. Many different types of habitats exist on the uplands, the exposed cliffs, the talus slopes and the lower grounds between the latter and the river. Pammel (24) in a comparative study of the vegetation of this area and similar ones along the Mississippi River in Minnesota and Iowa has treated in detail the vegetation of the many types of habitats. There are all kinds of plant associations with a most unusual mixing of boreal and austral, eastern and western elements. According to Pammel the exposed limestone flats at La Crosse are nearly 600 feet above the flood plain and in their younger stage have the "aspect of a typical prairie vegetation such as occurs in parts of Iowa."

The following 12 species of bees not found farther north along the Mississippi and St. Croix Rivers were taken at Genoa: *Hylaeus cressonii* Ckll., *Colletes productus* Robt., *C. albescens* Robt., *Sphecodes confertus* Say, *S. antennariae* Robt., *S. minor* Robt., *S. nephelotes* Lov., *Halictus forbesii* Robt., *H. hartii* Robt., *H.* (*Dialictus*) *anomalus* Robt., *Perdita maculipennis* Graen., *Coelioxys sayi* Robt.

At Wyalusing, Grant Co., a few miles south of the Wisconsin River, conditions were much the same as at Genoa. *Cassia Chamaecrista* was abundant along the railroad tracks, and the flowers were freely visited by *Bombus separatus* Cress., *B. impatiens* Harr. and *B. americanorum* Fabr., but *Anthophora walshii* Cress., an oligotrope of these flowers, was not seen although persistently looked for.

At Rutledge, Grant Co. the limestone cliffs facing the river showed in places the effects of weathering in the ragged appearance of the exposed rocks. Through erosion much of the top soil had been removed, and this probably was the cause of the absence or at least poor representation of some of the bees found more common at other stations.

Species not found elsewhere along the western border of Wisconsin were *Triepeolus remigatus* Fabr. and *Melissodes vernoniana* Robt.

A total of 180 species of bees have been collected in the territory bordering on the St. Croix and Mississippi Rivers in western Wisconsin, of which the following *have not been found* in the eastern part of the state: *Hylaeus modestus illinoiensis* Robt., *H. verticalis* Cress., *Colletes aberrans* Ckll., *C. nudus* Robt., *C. vicinalis* Graen., *C. albescens* Robt., *Sphecodes antennariae* Robt., *S. minor* Robt., *S. solonis* Graen., *Halictus parallelus* Say, *H. viridatus* Lov., *H. oblongus* Lov., *H. nigro-viridis* Graen., *H. hartii* Robt., *H. texanus* Cress., *Augochlora fervida* Sm., *A. persimilis* Vier., *Agapostemon texanus subtilior* Ckll., *Andrena alleghaniensis* Vier., *A. obscura* Robt., *A. nivaloides* Graen., *Macropis ciliata* Patt., *Panurginus asteris* Robt., *Perdita citrinella* Graen., *Epeolus lectoides* Robt., *E. interruptus* Robt., *Triepeolus simplex* Robt., *T. lunatus* Say, *T. concolor* Robt., *T. remigatus* Fabr., *T. obliteratus* Graen., *Melecta interrupta* Cress., *Heteranthidium zebratum chippewaense* Graen., *Hoplitis truncata* Cress., *Ashmeadiella denticulata* Cress., *Melissodes vernoniae* Robt., *M. vernoniana* Robt. *Xenoglossa strenua* Cress., *Anthophora bomboides* Kby., *Bombus ternarius* Say.

There are 7 oligotropes among them, viz. 3 of *Compositae: Panurginus asteris* Robt., *Melissodes vernoniae* Robt., *M. vernoniana* Robt. (both visiting *Vernonia fasciculata* according to Robertson); 2 of *Petalostemum: Colletes aberrans* Ckll., *Perdita citrinella* Graen.; 1 of *Cucurbita: Xenoglossa strenua* Cress.

F. PARASITIC BEES OF WISCONSIN AND THEIR HOST-BEES

Very little is known about the relations between our parasitic bees and their hosts. This subject offers a most interesting and fertile field of investigation, especially so in regard to the activities of the parasitic larvae in the nests of the host-bees.

Sphecodes Latreille

This genus is closely related to *Halictus*, and its species are parasites of the latter, so far as our information goes. Nothing definite is known about any of the species of our fauna.

Nomada Fabricius

Andrena, *Halictus*, *Panurgus* and *Colletes* are the genera figuring as hosts according to observations made in this country and Europe.

Packard cited by Ashmead (2) reported the breeding of *N. imbricata* Sm. and *N. vincta* Say from the nests of *Andrena vicina* Sm., and of the first named from nests of *Halictus parallelus* Say.

Epeoloides Giraud (**Viereckella** Swenk)

In Europe this genus parasitizes *Macropis* Panzer according to Alfken (1, p. 150). *E. pilosula* Cress. of the eastern U. S. is comparatively common at Milwaukee, where *Macropis morsei* Robt. occurs, and has been found in western Wisconsin all along the St. Croix and Mississippi Rivers, together with *M. morsei* (along the St. Croix) and *M. ciliata* Patton (along the Mississippi).

Epeolus Latreille

Parasites of *Colletes* Latr., *Epeolus bifasciatus* Cress. of our fauna is considered by Robertson (28) a parasite of *Colletes latitarsis* Robt.; both range into tropical Florida (17).

Argyroselenis Robertson

At Milwaukee *A. minima* Robt. parasitizes *Colletes eulophi* Robt., as reported by the writer (13).

Triepeolus Robertson

Parasites of *Melissodes* Latr. The relations of *T. helianthi* Robt. to its host-bee *Melissodes trinodis* Robt. as observed at Milwaukee, were described by the writer (12).

Stelis Panzer

Genera parasitized are *Osmia* Panzer, *Alcidamea* Cress., *Heriades* Spin., *Anthidium* Fabr. and *Ceratina* Latr.

In Colorado *S. sexmaculata* Ashm. has been bred by Hicks from *Alcidamea producta* Cress., and *S. crassiceps* Ckll. from the same host (18). The life history of *S. lateralis* Cress. (not *sexmaculata* Ashm. as stated) as a parasite of *Alcidamea producta* Cress. in Wisconsin was described by the writer (12).

Chelynia Provancher

C. subemarginata Cress. was bred from a nest of *Osmia simillima* Sm. in a dry piece of driftwood found by the writer on the shore of Lake Michigan at Milwaukee.

Coelioxys Latreille

The species parasitize mostly *Megachile* Latr., but also *Osmia* Panz. and *Anthophora* Latr. In Colorado *C. octodentata* Say was bred by Custer from *Megachile brevis* Say (reported by Hicks) and *C. coloradensis* by Hicks from *M. montivaga* Cress. (18).

Information on the habits and life-history of the following species was obtained by the writer (12 and 16) at Milwaukee and Cedar Lake, Washington Co., Wis. from the nests of leaf-cutter bees: *C. modesta* Cress. from *Megachile infragilis* Cress., *C. ribis* Ckll. from *M. wootoni* Ckll., *C. lucrosa* Cress. from *M. vidua* Sm. (not *addenda* as stated) and *C. dubitata* Sm. (*rufitarsis* Sm.) from *M. latimanus* Say and *M. wootoni* Ckll. (not *melanophaea* as stated).

Melecta Latreille

Parasites of *Anthophora* Latr. Robertson (28) considers *M. interrupta* Cress. a parasite of *Anthophora walshii* Cress. The former was taken by the writer in a region (Pierce Co., Wis., on the Mississippi River) where *walshii* was the only species of *Anthophora* to be found.

Psithyrus Lepelatier

The species are social parasites of the bumblebees from which they have been derived.

P. variabilis Cress. is a parasite of *Bombus americanorum* Fabr.

The relations between parasite and host have been closely observed by Frison (8). In reporting the occurrence of this species in southern Florida (17) the writer overlooked the fact that Dr. Frison had recorded it previously for Florida. Dr. Frison kindly called the writer's attention to his error.

G. LIST OF WISCONSIN BEES. DISTRIBUTION

The information on distribution in Wisconsin is based on records for 34 counties. The species are separated into 3 groups: 1—Found in Western Wisconsin only; 2—in Western & Eastern Wisconsin; 3—in Eastern Wisconsin only. With the exception of Milwaukee Co., the counties are, as a rule, not mentioned in the list.

Colletes Latreille

West. Wis.: *aberrans* Ckll., *nudus* Robt., *vicinalis* Graen., *albescens* Robt.

West. & East. Wis.: (Milwaukee, etc.) *eulophi* Robt., *armatus* Patt., *brachyceros* Swk., *latitarsis* Robt., *productus* Robt., *compactus* Cress., *aestivalis* Patt.

East. W. (Milwaukee, etc): *willistoni* Robt., *inaequalis* Say.

Hylaeus Fabricius (**Prosopis** Fabricius)

West. W.: *modestus illinoiensis* Robt., *verticalis* Cress.

West. & East. W. (Milwaukee, etc.): *basalis* Sm., *nelumbonis* Robt., *modestus* Say, *varifrons* Cress., *cressonii* Ckll. (*pygmaeus* Cress.), *saniculae* Robt., *ziziae* Robt.

Andrena Fabricius

West. W.: *nivaloides* Graen., *alleghaniensis* Vier., *obscura* Robt.

West. & East. W. (Milwaukee, etc.): *miserabilis flavoclypeata* Sm., *vicina* Sm., *nivalis* Sm., *forbesii* Robt., *fragilis* Sm., *ziziae* Robt., *crataegi* Robt., *multiplicata* Ckll., *wheeleri* Graen., *robertsonii* D. T., *peckhami* Ckll., *chromotricha clypeonitens* Ckll., *nubecula* Sm., *aliciae* Robt., *helianthi* Robt., *solidaginis* Robt., *asteris* Robt., *rudbeckiae* Robt.

East W. (Milwaukee, etc.): *cockerelli* Graen., *illinoensis* Robt., *radiatula* Ckll., *mariae* Robt., *erythrogastra* Ashm., *carlini* Ckll., *hippotes* Robt., *cressonii* Robt., *dubia* Robt., *erigeniae* Robt., *dunningi* Ckll., *placida* Sm., *milwaukeensis* Graen., *Parandrena andrenoides* Cress., *rugosa* Robt., *nasonii* Robt., *claytoniae* Robt., *fragariana* Graen.,

ziziae Robt., *geranii* Robt., *rufosignata* Ckll., *geranii maculati* Robt., *sigmundi* Ckll., *commoda* Sm., *thaspii* Graen., *perplexa viburnella* Graen., *hirticincta* Prov., *persimilis* Graen., *parnassiae* Ckll., *graenicheri* Ckll.

Eunomia Cresson

West. & East. W. (Milwaukee, etc.): *heteropoda* Say.

Halictus Latreille

West. W.: *parallelus* Say, *viridatus* Lov., *oblongus* Lov., *nigroviridis* Graen., *hartii* Robt., *texanus* Cress. (*Sphecodogastra texanus* Ashm.) found at Prescott, Pierce Co. collecting pollen from *Oenothera rhombipetala* after sunset as late as 10 P. M.; its nocturnal habits were described by the writer (14). It is a *Halictus* with enlarged ocelli (adaptation to nocturnal life), inhabiting arid regions of the West and Southwest (Tex., Rocky Mts.). Found by Stevens in Kans. and N. Dak. (34, 35), also in the Chicago region by Pearson (25).

West. & East. W. (Milwaukee, etc.): *lerouxii* Lep., *provancheri* D. T., *ligatus* Say, *coriaceus* Robt., *forbesii* Robt., *nelumbonis* Robt., *truncatus* Robt., *arcuatus* Robt., *quadrimaculatus* Robt., *foxii* Robt., *pectoralis* Sm., *graenicheri* Ellis, *vierecki* Crawf., *tegularis* Robt., *albipennis* Robt., *cressonii* Robt., *zephyrus* Sm., *pilosus* Sm., *sparsus* Robt. (Washington Co., not Milwaukee), *pruinosus* Robt., *lineatulus* Crawf., *hortensis* Lov., *versatus* Robt., *anomalus* Robt. (*Dialictus* Robertson).

East. W. (Milwaukee, etc.): *coeruleus* Robt., *testaceus* Robt., *cephalicus* Robt. (*Paralictus* Robertson).

Augochlora Smith

West. W.: *fervida* Sm., *persimilis* Vier.

West. & East. W. (Milwaukee, etc.): *viridissima* Vier., *confusa* Robt.

East. W. (Milwaukee, etc.): *pura* Sm.

Agapostemon Smith

West. W.: *fexanus subtilior* Ckll.

West. & East. W. (Milwaukee, etc.): *radiatus* Say, *virescens* Fabr., *splendens* Lep., *texanus* Cress. (Racine & Kenosha Cos., not Milwaukee).

Sphecodes Latreille

West. W.: *antennariae* Robt., *minor* Robt., *solonis* Graen.

West. & East. W. (Milwaukee, etc.): *confertus* Say, *arvensis* Patt., *stygius* Robt., *nephelotes* Lov., *prosphorus* Lov., *cressonii* Robt.

East. W. (Milwaukee, etc.): *ranunculi* Robt., *clematidis* Robt., *davisii* Robt., *mandibularis* Robt.

Halictoides Nylander

West. & East. W. (Milwaukee, etc.): *monardae* Vier. (The female, an oligotrope of the *Labiatae*, cannot be separated from that of *novaeangliae* Robt., an oligotrope of *Pontederia cordata* in Maine. An examination of the male genitalia by Viereck revealed the difference. First specimens found at Cedar Lake, Washington Co., Wis.); *marginatus* Cress. (Kenosha Co., not at Milwaukee).

Perdita Smith

West. W.: *citrinella* Graen. Found in N. Dak. by Stevens (33).

West. & East. W. (Milwaukee, etc.): *maura* Ckll., *bruneri* Ckll., *lacteipennis* Swk. & Ckll. (*pallidipennis* Graen.), *maculipennis* Graen. (*bruneri* and *lacteipennis* in Kenosha Co., not at Milwaukee). *Maculipennis* has been recorded by Timberlake for Savanna, Ill., Oregon, Ill., and Wittenberg, Mo., with a variety with yellow markings from the latter place leading to *P. maculigera* Ckll. described as var. *bilineata* Timberlake (39).

East. W.: *gerhardi* Vier. (Kenosha Co., not at Milwaukee). A subspecies *gerhardi arenicola* Timberlake (39) occurs at Meredosia, Topeka, Arenzville and Havana, all in Ill.

Calliopsis Smith

West. & East. Wis.: *andreniformis* Sm. (Milwaukee), *verbenae nebrascensis* Crawf. (Washington Co., not at Milwaukee).

Panurginus Nylander

West. W.: *asteris* Robt.

West. & East. W. (Milwaukee, etc.): *rudbeckiae* Robt.

Macropis Panzer

West. W.: *ciliata* Patt.

West. & East. W.: *morsei* Robt. (Milwaukee).

Nomada Fabricius

West. & East. W. (Milwaukee, etc.): *bella* Cress. (Polk Co., Cockerell), *albofasciata* Sm. (Polk Co., Cockerell), *vincta* Say, *superba* Cress., *graenicheri* Ckll., *cressonii* Robt., *florilega* Lov. & Ckll., *articulata* Sm. (*americana* Kby.), *cockerelli* Graen., *texana* Cress. (*wisconsinensis* Graen.).

East. W. (Milwaukee, etc.): *cuneata* Robt., *luteola* Oliv., *coloradensis* Ckll., *sayi* Robt., *simplex* Robt., *denticulata* Robt., *vicina* Cress., *obliterata* Cress., *rhodoxantha* Ckll., *sphaerogaster* Ckll.

Epeoloides Giraud

West. & East. W. (Milwaukee, etc.): *pilosula* Cress.

Epeolus Latreille

West. W.: *lectoides* Robt., *interruptus* Robt.

West. & East. W. (Milwaukee, etc): *bifasciatus* Cress., *pusillus* Cress.

Argyroselenis Robertson

West. & East. W. (Milwaukee, etc.): *minima* Robt.

Triepeolus Robertson

West. W.: *simplex* Robt., *lunatus* Say, *concolor* Robt., *remigatus* Fabr., *obliteratus* Graen. (described from Burnett & Pierce Cos.).

West. & East. W. (Milwaukee, etc.): *concavus* Cress., *cressonii* Robt., *donatus* Sm.

East. W.: (Milwaukee, etc.) *helianthi* Robt., *pectoralis* Robt.

Melecta Latreille

West. W.: *interrupta* Cress.

Anthophora Latreille

West. W.: *bomboides* Kby.

West. & East. W. (Milwaukee, etc.): *walshii* Cress., *terminalis* Cress. (*Clisodon* Cresson).

East. W. (Milwaukee, etc.): *abrupta* Say, *ursina* Cress.

Tetralonia Spinola

East. W.: *robertsonii* Ckll. (Milwaukee); *frater* Cress. (Racine Co. not Milwaukee).

Xenoglossa Smith

West. W.: *strenua* Cress.

Melissodes Latreille

West. W.: *vernoniae* Robt., *vernoniana* Robt.

West. & East. W. (Milwaukee, etc.): *agilis* Sm., *trinodis* Robt. *rustica* Say, *desponsa* Sm., *bimaculata* Lep., *obliqua* Say.

East. W. (Milwaukee, etc.): *nivea* Robt., *coloradensis* Cress.

Coelioxys Latreille

West. & East. W. (Milwaukee, etc): *alternata* Say, *moesta* Cress., *ribis* Ckll., *lucrosa* Cress., *modesta* Cress., *dubitata* Sm. (*rufitarsis* Sm.), *octodentata* Say, *sayi* Robt.

Megachile Latreille

This genus has been revised by Prof. T. B. Mitchell (23).

West. & East. W. (Milwaukee, etc.): *latimanus* Say, *pugnata* Say, *vidua* Sm., *infragilis* Cress., *montivaga* Cress., *wootoni* Ckll., *campanulae* Robt., *brevis* Say, *mendica* Cress., *pruina* Cress. (Kenosha Co., not Milwaukee).

East. W. (Milwaukee, etc.): *melanophaea* Sm. *mucida* Cress.

Heriades Spinola

West. & East. W. (Milwaukee, etc.): *carinatus* Cress.

Hoplitis Klug

West. W.: *truncata* Cress.

Ashmeadiella Cockerell

West. W.: *denticulata* Cress.

Andronicus Cresson

West. & East. W. (Milwaukee, etc.): *cylindricus* Cress.

Alcidamea Cresson

West. & East. W. (Milwaukee, etc.): *producta* Cress.

Monumetha Cresson

West. & East. W.: *albifrons* Cress.

Osmia Panzer

West. & East. W. (Milwaukee, etc.): *atriventris* Cress., *simillima* Sm., *bucephala* Cress.

East. W. (Milwaukee, etc.): *conjuncta* Cress., *coerulescens* L. (Holarctic), *pumila* Cress., *lignaria* Say.

Stelis Panzer

West. & East. W. (Milwaukee, etc.): *foederalis* Sm.

East. W. (Milwaukee, etc.): *lateralis* Cress.

Chelynia Provancher

West. & East. W. (Milwaukee, etc.): *subemarginata* Cress.

Heteranthidium Cockerell

West. W.: *zebratum chippewaense* Graen. Schwarz (32) considers *chippewaense* at best a variety of *zebratum*.

Dianthidium Cockerell

West. & East. W.: *simile* Cress. (Kenosha Co., not at Milwaukee).

Paranthidium Cockerell

West. & East. W.: *jugatorium* Say (Washington Co., not at Milwaukee).

Ceratina Latreille

West. & East. W. (Milwaukee, etc.): *dupla* Say.

East. W. (Milwaukee, etc.): *calcarata* Robt.

Psithyrus Lepeletier

West. & East. W. (Milwaukee, etc.): *ashtoni* Cress., *variabilis* Cress.

East. W. (Milwaukee, etc.): *variabilis tricolor* Frankl. (Outagamie Co. record by Frison, not at Milwaukee), *laboriosus* Fabr.

Bombus Latreille (**Bremus** Panzer)

West. W.: *ternarius* Say.

West. & East. W. (Milwaukee, etc.): *terricola* Kby., *vagans* Cress., *fervidus* Fabr., *borealis* Kby., *impatiens* Harr., *americanorum* Fabr., *separatus* Cress.

East. W. (Milwaukee, etc.): *affinis* Cress., *perplexus* Cress., *bimaculatus* Cress., *fraternus* Sm. (Green Lake, record by Frison, not at Milwaukee), *rufocinctus* Cress. (Door Co., not at Milwaukee).

Apis Linnaeus

Entire W.: *mellifica* L. (*mellifera* L.).

H. BIOTA AND BIOTIC AREAS

The boreal region of Wisconsin forms a belt across the northern part of the state which extends in the northwestern corner southward along the St. Croix River to the mouth of the Yellow River, a tributary of the latter (latitude about 46′). In eastern Wisconsin the southern limit of the boreal belt reaches Green Bay near the mouth of the Menomonee River (latitude about 45′).

As represented on the life zone map of the U. S. Biological Survey (22), the upper austral zone occupies a small area in the southeastern corner of the state, and one similar in size and shape in the southwestern corner. The broad area between the boreal and austral belonging to the transition zone is considerably larger than the other two combined.

The bee fauna of the boreal of northwestern Wisconsin contains along with the characteristic species of northern distribution a large percentage of austral elements, the following of which range southward into the tropical region of extreme southern Florida: *Bombus separatus* Cress., *Ceratina dupla* Say, *Megachile mendica* Cress., *M. brevis* Say and *Agapostemon splendens* Lep. Some of the typical boreal species, on the other hand, extend their range far into northern or northwestern Canada, and the higher altitudes of the Rocky Mountains. Such are: *Hylaeus basalis* Sm., *H. verticalis* Cress., *H. varifrons* Cress., *Osmia bucephala* Cress., *Anthophora bomboides* Kby., *Bombus borealis* Kby., and *Andrena nivalis* Sm. The species cited above furnish some of the more striking examples of a wide range of distribution.

Of especial interest are the oligotropic bees, the distribution of which depends on that of their host-plants. Altogether 54 species of oligotropic bees are known from Wisconsin, 20 of which are eastern, while the remaining 34 are either exclusively western or extend their range from the western states to the states east of the Mississippi River, some of them reaching the Atlantic coast.

The 20 species of eastern distribution are the following: *Colletes aestivalis* Patt., *Halictus nelumbonis* Robt., *Andrena erigeniae* Robt., *A. ziziae* Robt., *A wheeleri* Graen., *A. geranii maculati* Robt., *A. peckhami* Ckll., *A. asteris* Robt., *A. rudbeckiae* Robt., *A. persimilis* Graen., *A. graenicheri* Ckll., *A. parnassiae* Ckll., *Macropis ciliata* Patt., *Halictoides monardae* Vier., *Panurginus rudbeckiae* Robt., *Perdita gerhardi Vier., Megachile campanulae* Robt., *Melissodes rustica* Say, *M. vernoniana* Robt., *Tetralonia robertsonii* Ckll.

Of the remaining 34 species which are either exclusively western, or range from the Rocky Mts. or beyond through the prairie region into the eastern United States, there are 19 oligotropes of *Compositae* (*Colletes armatus* Patt., *C. compactus* Cress., *C. americanus* Cress., *Andrena chromotricha clypeonitens* Ckll., *A. solidaginis* Robt., *A. aliciae* Robt., *A. nubecula* Robt., *A. helianthi* Robt., *A. hirticincta* Prov., *Halictoides marginatus* Cress., *Perdita lacteipennis* Swk. & Ckll., *P. bruneri* Ckll., *Panurginus asteris* Robt., *Megachile pugnata* Say, *Melissodes agilis* Sm., *M. trinodis* Robt., *M. coloradensis* Cress., *M. desponsa* Sm., *M. vernoniae* Robt.), 3 of *Physalis* (*Colletes latitarsis* Robt., *C.*

willistoni Robt., *Perdita maura* Ckll.), 2 of *Petalostemum* (*Colletes aberrans* Ckll., *Perdita citrinella* Graen.), 1 of *Campanulaceae* (*Colletes brachyceros* Swk.), 5 of *Salix* (*Andrena cockerelli* Graen., *A. illinoensis* Robt., *A. mariae* Robt., *A. erythrogastra* Ashm., *Parandrena andrenoides* Cress.), 1 of *Rosaceae* (*Andrena fragariana* Graen.), 1 of *Steironema ciliata* (*Macropis morsei* Robt.), 1 of *Cucurbita* (*Xenoglossa strenua* Cress.), 1 of *Cassia Chamaecrista* (*Anthophora walshii* Cress.).

The *Compositae* with their 19 oligotropes are foremost among them. Many of the species of *Helianthus*, *Solidago*, *Aster*, *Lepachys*, *Silphium*, *Liatris*, *Grindelia*, etc. which are characteristic plants of the prairie flora, are well represented in Wisconsin. They are late bloomers, and furnish pollen to 6 oligotropic species of *Andrena*, 5 of *Melissodes*, 3 of *Colletes*, 2 of *Perdita*, 1 of *Megachile*, 1 of *Halictoides*, and 1 of *Panurginus*. Other important host-plants of the prairie region occurring in Wisconsin are species of *Physalis* and *Petalostemum*, the former being visited by 2 oligotropic species of *Colletes*, 1 of *Perdita* and the latter by 1 *Colletes* and 1 *Perdita*.

Many of the oligotropes of western distribution range northward along the Mississippi and St. Croix Rivers well up into the transition zone; the following were taken on the border line between the transition and boreal at the mouth of the Yellow River: *Andrena solidaginis* Robt., *Panurginus asteris* Robt., *Perdita lacteipennis* Swk. & Ckll., *Melissodes agilis* Sm., *M. trinodis* Robt., and *Anthophora walshii* Cress., all but the last-named being oligotropes of species of *Compositae*. Within the boreal farther north *Megachile pugnata* Say, *Andrena chromotricha clypeonitens* Ckll., *Macropis morsei* Robt. with its parasite *Epeoloides pilosula* Cress. occur.

A total of 79 species of bees were obtained from the boreal region of northwestern Wisconsin from July 7–28.

In southeastern Wisconsin characteristic elements of the prairie region are found in various kinds of habitats, the same as in the Mississippi and St. Croix valleys. Two such areas differing in their general appearance, as also in the composition of their biota, were treated more in detail. One of these, a typical strip of prairie in Racine Co. with most of the floral elements of a western prairie, was found to have an unexpectedly small number of bees, due undoubtedly to soil conditions unfavorable to their nesting activities. The other, the Kenosha-Waukegan dune area along Lake Michigan with its pines and oaks presents a picture entirely different from that of a typically treeless western prairie. In addition it consists of two distinct types of biota fairly well separated from each other, the one bordering on the lake being of a boreal character, and the other, which is far enough away from the lake to escape its cooling influence, showing a preponderance of austral elements, both of plants and bees. The bees were much more in evidence in this area than in the typical prairie of Racine Co. referred to above.

The surroundings of Milwaukee furnish another example of a region with habitats (dry hillsides, high grounds, sandy areas) favoring the occurrence of prairie plants and their associated bee-fauna.

The information gained from a study of the conditions in the St.

Croix and Mississippi valleys, those of the Racine prairie, the Kenosha-Waukegan dunes and the Milwaukee region, points to a diversity of habitats offering a foothold to elements of the prairie vegetation. The occurrence of these plants under such seemingly different conditions is explained by the fact that plants from dry regions entering areas of less aridity adapt themselves to soils best fitted to their needs. The bees follow the plants into new territories, and the soil conditions suitable to the latter may not always suit the bees, as shown by the poorly represented bee fauna of the Racine prairie.

The dune area of Two Rivers, Manitowoc Co., Wis., along Lake Michigan, presents about the same physiographic features as the Kenosha-Waukegan dune area along Lake Michigan in southeastern Wisconsin and northeastern Illinois, and the biota of that part of each of these areas bordering on the lake and under the influence of the latter is of the same type. The wooded section, however, with its northern conifers and its two northern poplars (*Populus balsamifera* and *P. grandidentata*) reveals the boreal character of the Two Rivers dunes at first sight, while the wooded portion of the Kenosha-Waukegan dunes with its oaks, etc., points to its austral character. As regards the bee fauna, a comparison shows that 22 species of the Kenosha-Waukegan dunes, including 8 oligotropes, all of them austral, were not found at Two Rivers, while 9 boreal species of the Two Rivers area, 1 of them an oligotrope, do not reach the Kenosha-Waukegan dunes although they range south as far as Milwaukee. The dunes of Two Rivers are situated in that part of Manitowoc Co. having, according to the isotherms (43), a mean summer temperature (months of June, July and August) between 65° and 66°, and this agrees with the mean summer temperature of the boreal region of northwestern Wisconsin in Douglas Co. and the upper part of Burnett Co. considered previously. The isotherm for 66° passes through the region near the mouth of the Yellow River in Burnett Co., and in eastern Wisconsin it reaches the western shore of Green Bay near the mouth of the Menomonee River at about the same point where, according to the life zone map, the southern border line of the boreal region strikes Green Bay. This isotherm, as also those to the north and south of it, takes a sharp southward course where it approaches Lake Michigan, while on the western side of the state the isotherms of mean summer temperatures take a sharp northward course near the Mississippi and St. Croix Rivers. This indicates plainly the influence of Lake Michigan which favors a southward range of boreal elements along the lake, some of them reaching northeastern Illinois; on the western side of the state it shows the influence of the high summer temperatures of the Mississippi and St. Croix valleys with the resulting northward extension of the range of austral elements, including some of the characteristic prairie biota.

This brief account of the distribution of the bee-fauna of Wisconsin is based on a satisfactory acquaintance with the fauna of the Milwaukee region, of some other parts of eastern Wisconsin, and information for the western part of the state (St. Croix and Mississippi valleys) covering the summer months from July on.

The state of Wisconsin has an area of over 56,000 square miles, within the confines of which boreal and austral elements meet and intermix with elements from the deciduous forests of the East and the prairies and arid regions of the West. It undoubtedly holds many problems in store for students of distribution.

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APPLIED ENTOMOLOGY. By H. T. FERNALD. 405 pages, 384 figures. Third edition. New York and London: McGraw-Hill Book Company, Inc. $3.50.

First published in 1921 this book has been used widely in courses of economic entomology. Professor Fernald believes that beginning students require a general knowledge of the broad outline of the subject and means by which they can recognize important insect pests they are liable to meet in the course of their work. Conservative yet wide in scope this volume, now in the third edition, has met with such approval that it has persisted with little change from the original organization. The author has kept abreast with developments in insect control and gleaned the literature for new and more accurate data on the biology of our more important pests.

Those who are familiar with the second edition will find extensive changes in the chapters dealing with Contact Insecticides, Stomach Poisons, Fumigants, Stickers and Spreaders, and Combinations of Spray Materials. Other changes include discussions of Insect Benefits, Biological Control, and several insects that have become of economic importance during the last few years. Some few illustrations have been omitted and six new ones added.

Examination of this book arouses admiration for the qualities that went into its compilation and frequent revision—the careful sorting and classifying of material, and the interesting manner of presentation.—B. J. L.

THE MADRID ENTOMOLOGICAL CONGRESS

HERBERT OSBORN

Whether or not one is able to attend the coming Congress of entomologists at Madrid every active entomologist must be interested in the proceedings of this international meeting of entomologists. Aside from the strictly technical parts of the Congress there are many social features and everyone will agree that the opportunity to meet the entomologists of other countries and to form acquaintanceships and friendships that are a continuing pleasure is one of the major interests of such meetings. The previous congresses, Brussels, 1910; Oxford, 1912; Zurich, 1925; Ithaca, 1928, and Paris, 1932, have all been notable occasions and we may be confident that the one in Madrid will be of equal interest. Having had the good fortune to attend all except the one at Zurich, the writer can testify from personal experience to the interest and profit in attendance on the technical sessions and especially to the pleasure of knowing personally many of the leading entomological workers of foreign lands. In addition to the professional aspects of this congress it affords an opportunity to visit under advantageous conditions a country replete with historic interest and to most of us a "terra incognita." It is to be hoped that there will be a large and influential delegation from the Americas, one commensurate with the entomological activities this side the Atlantic. Undoubtedly there will be questions of international interest before the congress, some of which must be of importance in our entomological progress.

Proceedings of the Twenty-ninth Annual Meeting:

A Correction

On page 190, Volume XXVIII, was announced the appointment of a "Committee to Consider a Revision of Smith's Glossary": Dr. W. P. Hayes, Dr. B. B. Fulton and Dr. P. P. Calvert, *Chairman*. We correct the above. Dr. W. P. Hayes is Chairman.—THE MANAGING EDITOR.